The Dock and Harbour Authority

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Editorial Comments

Volume Twenty.

This issue marks the commencement of a new volume—the twentieth of the series. It is regrettable that the event takes place under circumstances so unpropitious for the continued progress and prosperity of the Journal. Last month, we penned an appeal to our subscribers and advertisers, asking them to make considerate allowance for the difficulties under which the Journal is at present produced, and we are gratified at the generous support which is forthcoming as heretofore. We hope to improve our service as time goes on and meanwhile we desire to express our warm appreciation of friendly encouragement and kindly help.

Stockton, a Flourishing Californian Port.

Somewhat outshone, no doubt, in shipping importance by the adjacent and more widely-known port of San Francisco, yet having a distinct and growing reputation of its own as a notable inland centre of navigation extending to and over the high seas, the Port of Stockton, located on the right bank of the San Joaquin River in California, which discharges into the Bay of San Francisco, claims attention in the present issue. Colonel B. C. Allin, the enterprising Director of the Port has been good enough to prepare the account of its recent origin and present activities which appears on another page. In point of years, the port has no lengthy record, but in growth and recent development, it is a striking feature among United States ports and, combining as it does a strategic fluvial location with ready access to the Pacific Ocean, it bids fair to take a leading place in American overseas and inland commerce.

On the analogy of the origin of nomenclature in the case of a number of new world ports, it might be supposed that the Port of Stockton, California, derived its name from, and had some ancestral association with, the English port of Stockton-on-Tees. This, however, is not so. The Californian town was founded in the year **1849** and was named, it is stated, after Robert Field Stockton, who had been prominent in the events which secured California for the United States, for it has to be realised that possession of the State in its early days was the aspiration of several claimants, Britain and France among the rest. Its valuable resources in gold, as well as the fertility of the soil and the mildness of the climate, made it a desirable acquisition for any colonising country. In the San Joaquin Valley, which is the hinterland of Stockton, there are produced rich crops of potatoes, onions, beans, corn, asparagus, grapes and fruit. Like ancient Canaan, it is a land " flowing with milk and honey."

Amid so many natural advantages, it is not surprising that Stockton has greatly flourished during the relatively short period of its existence, and there is every prospect that the present enterprising development of the port accommodation will lead to even more striking progress in trade and shipping in the future.

Mobile Labour Supply at Ports.

As described in detail in another page, a mobile column of voluntary port labourers, or what is picturesquely described in the popular press as a " Flying Squad," is in process of formation to allow of the prompt transfer of skilled dockers from one port to another as occasion may demand. This action is preparatory to the initiation of a policy for the diversion of shipping from damaged or threatened ports to others in safer localities. A scheme has been drawn up by the Ministry of Labour, in conjunction with several bodies of organised labour, whereby groups of men can be moved at short notice, by train or motor coach, to places where the local supply of labour is inadequate. The men will retain their civilian status and have the benefit of certain advantageous concessions.

The Government is giving financial aid to the scheme, which is mainly sponsored by the Transport and General Workers Union, whose general secretary, Mr. Ernest Bevin, has issued an appeal to his dock-members to enrol at the union offices in the various ports. The voluntary nature of the engagement is emphasised, in contrast to the militarisation of labour, which was in vogue during the last European War. The terms offered are liberal and there should be a ready response.

The announcement of the formation of the corps elicited an amusing broadcast from a German wireless station in which the corps was described as " a brigade of strike breakers and blacklegs, on the American model." Mr. Bevin made a suitable and cutting rejoinder in which he asked whether German transport workers would not welcome the freedom of English dock labour to negotiate agreements " instead of the suppression they have had to suffer since the Hitler régime."

English Channel Ports and the British Expeditionary Force.

It was only right and fitting that mention should have been made in the statement of the Minister for War in the House of Commons on October **11**th, respecting the transport over Channel of the British Expeditionary Force (numbering **158,000** men within a period of five weeks from the outbreak of war), of the important part played by certain ports in this country and in France, where and while the intricate operations of embarkation and disembarkation took place. The conditions were altogether different and much more exacting than in **1914**, when the men were conveyed in ordinary vessels, with material capable of being handled by the normal port equipment. In the present instance the men travelled separately, and the heavier mechanical equipment had to be brought from more distant ports where special handling facilities were available. The consignments comprised more than **25,000** vehicles, including tanks, some weighing **15** tons and over. These units were conveyed in special vessels, and the handling naturally required the services of experienced stevedores.

That the whole series of complicated operations was performed without any serious hitch, the entire force being transported " intact and without a casualty to any of its personnel," redounds to the credit of the officials and men of the ports concerned. It is a practical demonstration of the efficiency of the organisations at British and French ports.

Baltic Ports and Political Movements.

Under the influence of political events in North-Eastern Europe certain important changes are taking place in the character of ports in that quarter of the Baltic Sea. Hitherto regarded purely as trading centres, certain ports on the seaboard of Esthonia, Latvia and Lithuania have, in consequence of the partition of Poland and the Russo-German agreement, acquired a military significance, and steps have been taken by Russia to appropriate the chief of them as naval bases. To discuss the policy which has dictated this action and its possible ultimate effects does not lie within the purview of this Journal, but there are certain economic consequences which will inevitably follow the creation of these military protectorates. Trade will, undoubtedly, be directed or diverted in the interests of the dominant Power, and from a status of theoretical neutrality, the ports can be virtually, or actually, closed against shipping of countries which are, or

Editorial Comments – continued

may come to be, regarded as hostile by the alien sugerainty. To what extent this will affect, immediately or later, the movements of merchant shipping remains to be seen, for the present political situation in the Baltic countries is extremely obscure.

The intrusion of Russian control, or "wise guidance" as it is diplomatically described in Soviet circles, into neighbouring territories has been extended to the islands of Osel and Dago, belonging to Esthonia, which command the Gulf of Riga, and there has even been talk of the Aaland Islands, in which Finland and Sweden are jointly interested, becoming involved in the "negotiations" with Finland. Fortifications erected on these islands could be utilised to prevent the transport of valuable supplies of iron ore, timber and other materials from ports in the Gulf of Bothnia. It was suggested at one time, indeed, that Germany had a mind to the occupation of the islands, which are a fairly numerous group at the entrance of the Gulf of Bothnia. Should they fall into the hands of her Soviet partner, the situation for Germany would hold possibilities which it might not be altogether agreeable for her to contemplate.

War-Time Insurance of Floating Plant.

A point of special importance to port and harbour authorities is the insurance against war risks of their floating plant, which frequently includes units of powerful calibre, costly to replace and difficult to obtain without prolonged delay. Unfortunately, at the majority of British ports the risk is so great that the premiums quoted for such policies are strongly deterrent and almost prohibitive. Amongst other bodies who have had the matter under consideration, is the Clyde Navigation Trust, who obtained quotations for their own plant and came to the conclusion that the cost would be too heavy, so that the committee concerned recommended the Trustees to accept the risk themselves, as they did during the last war. It may be questioned whether the risk in the present hostilities is not very considerably greater than before, but the Trustees evidently felt that it could be faced, and they decided to take no action towards war insurance. Dealing with an allegation of profiteering on the part of the Insurance Companies, it was pointed out that all war risk insurance premiums were controlled by the Government, who took a large proportion of the risk.

The question is a very difficult one to decide in general terms and it affects not merely floating plant, but all port appliances, and indeed is common to structural property throughout the country. The chances of a direct hit may be as much as a thousand to one, as experience goes to show in connection with attacks on units of the Royal Navy, but a successful shot would entail devastation so complete, that the craft affected would without question be a "total loss."

Dock Gates.

The subject of Dock Gates, which is discussed in Mr. F. M. Easton's Paper reproduced in this issue, is of more than ordinary interest to dock engineers, since on the efficiency and reliability of these often huge and weighty structures depend the safety and mobility of the shipping using the docks which the gates enclose. Ease and steadiness of movement, with accuracy of fit, as well as strength and durability, are considerations of the highest importance, so that the design of dock gates is a specialist undertaking, calling for wide knowledge and experience, only to be gained by intensive study and by a practical acquaintance with varying local circumstances.

Dock gates, nowadays, are of almost gigantic dimensions, with leaves, in pairs, ranging up to 70-ft. by 55-ft. or more, and weighing several hundred tons each in the swinging condition. In earlier days, lock entrances rarely attained 100-ft. in width, this being the exceptional width of the Canada Lock at Liverpool, built in 1856 and influenced by the wide beam of the paddle steamers of the period; but at the present time, they have widths of 130-ft. or more, and the design of gates with double leaves for such entrances is a matter which requires great care and judgment. The use of solid timber, so common in the smaller gates, has had to give way to the superior strength and lighter construction of steel framework with buoyancy chambers.

Single-leaf gates, or box gates, rotating on a horizontal axis at sill level, constitute a separate type which has been described in the Paper on Dover Dock Gates, in our February issue, while the Cherre System of Tilting Gate was noticed in the July issue, both of this year.

Port of London Annual Report.

The thirtieth annual report of the Port of London Authority, excerpts from which will be found in another column of this issue, shows a slight recession in the hitherto almost unchecked upward trend of the trade of the port. From 47½ million tons in 1926, the returns of net register tonnage of vessels that arrived and departed, has increased to 62 million tons in the past financial year; some 900,000 tons less than the high record of almost 63 million tons in 1938. The previous break in the scale of steady progress was during the three years following the financial depression of 1931.

The prosperity of the chief national port is an index of the expansion of British overseas trade and the present report is a gratifying testimonial to the efficiency and capability of the Authority which administers its affairs. Since the inauguration of the Port Authority in the year 1909, the value in sterling of the total foreign trade of the port has practically been doubled.

Passenger Comfort at Ports.

Our persistent advocacy of greater consideration for the physical comfort of passengers at British ports has not yet achieved the measure of success which we nad hoped. We commend to the earnest attention of responsible officials the following extract from a recent issue of a leading London Daily Paper.

"Complaints from American travellers when the American liner "Washington," left an English port were loud and bitter. . . The boat train reached the quayside at mid-day. It was four-and-a-half hours later before the last of the passengers had been allowed on board. During that time they stood in a queue in a draughty shed. There was nowhere to sit down. Refreshments were unobtainable. The addition of a few officials would have doubled the rate of progress."

We wonder, and keep on wondering, at the seemingly illimitable patience of the travelling public and the indifference of the authorities. It is true that war-time conditions prevail, but could nothing have been done to prevent a most unfortunate impression of British port management being taken home by American visitors?

The Port of Antwerp and the War.

We alluded last month to the disastrous effect which the outbreak of war had had on the trade of German ports on the seaboard of the North Sea. Unfortunately, as indeed, almost inevitably, the harmful consequences of the naval blockade have extended over a wide area and have affected neutral countries no less than those of the actual belligerents. For the time being seaborne trade has been seriously disturbed and the movements of shipping have undergone drastic interference with their sailing schedules and routes.

The experience of Antwerp is a striking example. It is reported that, during the first month of hostilities there had been a decline of as much as 75% in the normal tonnage of shipping entering the port. As might have been expected, no German vessel has reached the place since the outbreak of war, with the exception of a small coasting steamer which took refuge in the Scheldt on August 28th and reached Antwerp some ten days later to discharge a cargo of Polish coal from Gdynia, originally destined for France. The lack of shipping to be handled has had deplorable results in regard to port labour and a very disquieting rise has taken place in unemployment figures. Employers have been perplexed with the problem of finding work enough for their old and experienced hands, whom obviously it would be difficult to replace, if they were discharged. An endeavour has been made to obtain assistance from the Belgian Government, particularly in regard to the statutory obligation imposed on employers to give their employees a minimum of three months' notice. The port authority itself is faced with the termination of leases for regular berths, quayside sheds and storage space, the result of which must be a serious drop in port revenue, in addition to the loss of hire charges for the use of quay cranes and appliances and other miscellaneous revenue.

Cork Harbour as an Atlantic Terminal Port.

A suggestion has been put forward and was recently discussed at a meeting of the Cork Harbour Board, that, during the continuance of the war, the United States Shipping Lines be invited to regard Cork Harbour as the European terminal for their transatlantic sailings, on account of the restrictions necessarily operating in the Irish Sea and the English Channel. The matter was referred to a committee for a detailed report on the proposal.

Whether passengers for Great Britain would appreciate being landed on the wrong side of the Irish Sea, with all the uncertainties and discomforts of a cross-channel connection, is a question which cannot be ignored, and although, as claimed, Cork Harbour may offer all facilities for handling steamers and refuelling, yet since it is remote from the ultimate destination of travellers, it is difficult to see that the suggestion can meet with general approval. The reduction in the length of voyage may, indeed, reduce the risk of torpedoing or sinking by gunfire, from which even American vessels can hardly consider themselves entirely exempt, but the additional distance to Plymouth, or Southampton is relatively so small, that the inducement to curtail the normal route is but slight. As regards freights carried on the steamers, the extra handling and transfer would add materially to the cost of transport. On the face of it, the proposal stands to benefit the Eire port at the expense of English ports, without apparently conferring any appreciable advantage on the shipping companies concerned, and certainly acting to the detriment of the travelling public.

Grain Terminal at the Port of Stockton.

The Port of Stockton, California

A Modern Port on the Pacific Coast

By B. C. ALLIN, Director of the Port.

California and its Products.

THE United Kingdom and Continental Europe scored another reduction in costs in obtaining their food products from Northern California in a decision recently handed down by the United States Maritime Commission.

The Commission ordered that Pacific Coast European Lines, operating from Pacific Coast ports, extend to Stockton, California, the same rates they apply from San Francisco Bay ports. Thus, the buyer and ultimately the consumer in the United Kingdom and Continental Europe may now secure their cotton, canned goods, dried fruit, dried milk, and malting barley at a transportation saving of approximately $1.00 a ton under what they paid prior to April 30th, 1939.

California has been rightly named the " bread basket of the world " because here, within a radius of 120 miles from Stockton is produced most of the canned goods, dried fruit, raisins, barley and dried milk that is exported to Europe.

Climatic conditions and soil make it possible for the heavy production of these commodities in this territory. To prepare this fruit for market there are 36 canneries and 63 packing plants operating in the large fruit and grape belt. Here, too, are the largest packers of asparagus which is exported to Europe.

Prior to the building of the Port of Stockton in 1933, all of the products exported to Europe were forced to move through the San Francisco Bay ports, but now by moving the Pacific Ocean 88 miles further inland where it taps this vast valley producing heavily of commodities going to Europe, it has become possible for the saving to be made in the through transportation costs.

The Federal Government and the State of California recognised the extra burden in transportation charges that this district was paying and supplied large funds for the creation of the Port of Stockton to free this tonnage to world markets at lesser transportation costs.

In the vast valleys of central California runs a network of highways at floor level; thus the transportation cost from the packer or canner is reduced to the lowest minimum in the transportation of these products to the Port of Stockton where they are laden aboard ships sailing direct to Europe.

Last year this port reached its highest peak in tonnage. This year it is expected this figure will be boosted to around 750,000 tons because the calling of ships here direct for the ports of Europe will increase the present tonnage another 100,000 tons.

The inauguration of European service has created such an interest in future production that several new canneries have started operations this year, and as a huge crop of food products will be harvested soon, it is expected that exportations will be much larger than they were last year.

Industries of Stockton and District

At the Port of Stockton one will find a large grain terminal, publicly owned but privately operated, handling about 100,000 tons per year, and a cotton compress, capable of compressing 125,000 bales of cotton a year.

The Pacific Molasses Company has erected a large tank here for the storage of molasses which is brought in by tank vessels from the Hawaiian Islands for distribution throughout the valley for feed purposes.

Much of the lumber that is used for construction work in the central valleys comes from the States of Washington and Oregon in the Pacific Northwest, and moves through Stockton for distribution largely by truck.

The largest chrome ore mine on the Pacific Coast has started operations at Folsom, California, where the ore is reduced to concentrates. These concentrates are loaded aboard vessels here for the Atlantic Coast where the chrome ore goes into the stainless steel production.

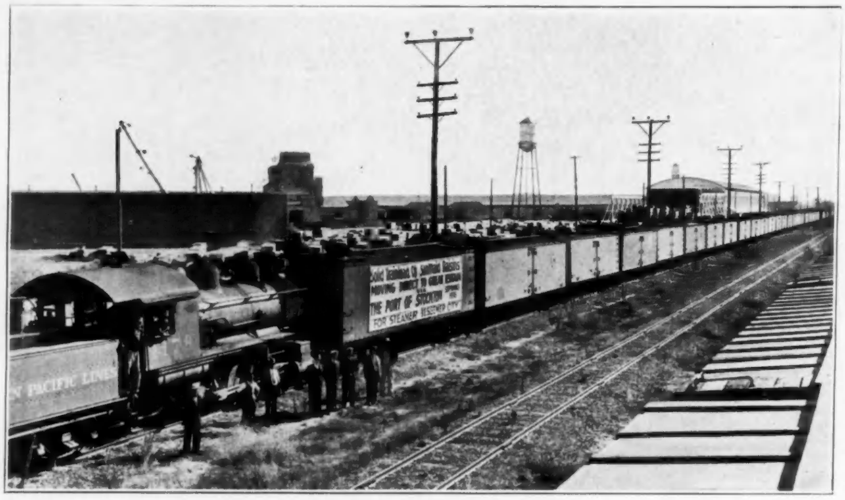
Since the port was opened in 1933 some seventeen new industries have come to Stockton to locate permanently, adding one-million-and-a-half dollars to the pay rolls.

The Stockton Terminal

The terminal of the Port of Stockton has been laid out in a comprehensive manner with certain controlling factors which are found in very few, if any, terminals in the United States. The first and major basic consideration has been the question of a balance of warehousing area in support of the transit shed berthing space. As a rule, port facilities either involve wharf transit sheds to the exclusion of any supporting warehouse area, or else some particular wharf is designed and constructed with multiple storeys as a warehouse in itself.

Both of these systems have defects, the first in that warehousing is confronted with delay and cost of handling often for considerable distances through congested commercial arteries of traffic, and in the second case, the wharf warehouse always forces a steamer to move from its usual berth.

Port of Stockton, California—continued



Consignment (Train Load) of Raisins for Great Britain via Stockton.

In 1932, the City of Stockton constructed three wharves together with necessary railroad facilities, roadways, drainage, water lines, etc. The combined length of these docks was 1,437-ft., providing berthing space for four ships. This development consisted of one open wharf with an area of 38,960 sq. ft. and two covered wharves, the combined transit shed area of which is 121,600 sq. ft.

A year after completion, these facilities were proving inadequate to handle the ever-growing stream of cargo coming through this port, and new ones had to be provided.

Recent Developments

In February, 1934, the Stockton Port District voted bonds in the amount of $900,000 for wharf construction and various other purposes. Applying on this, a P.W.A. grant of $230,000 was obtained. The first step taken in connection with the new project was the necessary dredging. This required widening of the present channel to provide necessary depth at the harbour line and the dredging of the first slip in the comprehensive plan of development of this port. Contract for this dredging was awarded to the Hydraulic Dredging Company on April 24th, 1934, at a cost of approximately $103,000 and involved the moving of about 800,000 cubic yards of earth. This was completed in July, 1934.

Plans for the new wharves and sheds were completed in June, 1934, and bids were taken in July of the same year. Contract for their construction was awarded to Robert E. McKee early in August. Work was started immediately.

This contract involved the construction of four wharves and four transit sheds together with the necessary railroad and highway facilities as well as drainage and water lines; 1,743 lineal feet of dock and 185,000 square ft of covered transit shed area was provided for under this contract.

Wharves 5 and 6 were extended westerly from Wharf 4, constructed in 1933, and aggregated a total of 832-ft. from the west end of No. 4. Wharves 7 and 8 parallel slip No. 1 and extend a distance of 911-ft. from the main channel wharf line. The accompanying general plan shows clearly the relative location of these sheds as well as locations of roads and rail facilities. The track and building arrangement is covered by a patent held by the Director of the Port.

The new construction is very similar to that of the old wharves. The sectional view shown in connection with the general plan shows the type of construction followed, and also how the wharves were set over the dredged sections to obtain necessary water depth. The sub-structure of these wharves is entirely of reinforced concrete resting on creosoted wooden piling or concrete spread footings. The sheds are of steel frames with corrugated iron siding, and composition roof laid on a 2-in. wood deck. The front portions of the transit sheds are supported on the wharf structure with an apron 31-ft. wide carrying double tracks. The rear portion of these sheds is on filled soil. Floor level elevation over this area is about 18.5 above U.S.E. Datum. In order to obtain proper soil conditions for the spread footings supporting columns for steel frame of sheds in this filled area, it was necessary to excavate to approximately an elevation of 3.0.

In the case of the terminal at Stockton, the ultimate possible flexibility and economy in concentration of freight has been attempted. A system has been used of grouping seven or eight steamship berths around the warehouse area, the entire area being intra-plant as it were, and connected by a system of concrete roadways in order that small wheel stevedore gear can, with facility, inter-connect any section of the warehouse area with any ship berth.

The only exceptions to this general scheme are in the case of commodities which have special requirements such as bulk grain or cold storage products. In the case of bulk grain, a conveyor from the grain warehouse is provided to ship side, and in the case of cold storage commodities, the plant when constructed will be connected with ship-side by insulated conveyor systems.

The comprehensive plan of the one piece of property which is currently being developed by the Stockton Port District, provides in general for two groups of wharves. In the case of one of these groups, the major portion of the warehouse area is divided approximately equally between grain and general commodity warehousing, with provision also for a certain amount of lumber and cold storage facilities. In the case of the other group not yet constructed, half of the warehouse area is already improved for the handling of cotton, and the other half designed for general commodities.

All highways, wharf entrances, and roadways are looped, in order that any part of the facilities may be easily served by trucks with trailers, and in order that none of this equipment will find it necessary to negotiate difficult manœuvres in extricating itself from its point of loading or unloading. All of the facilities are equally well served by rail as by truck, being completely equipped with railroad trackage paved flush with the ball of the rail, in order to serve both methods of transportation.

The warehouse facilities are equipped with automatic sprinklers in order to prevent the accumulation of a fire hazard in this area.

Wharf Construction

In the construction of the wharves, certain general considerations may be of interest. To begin with, no batter piles whatsoever have been used, nor have any bulkheads been provided.

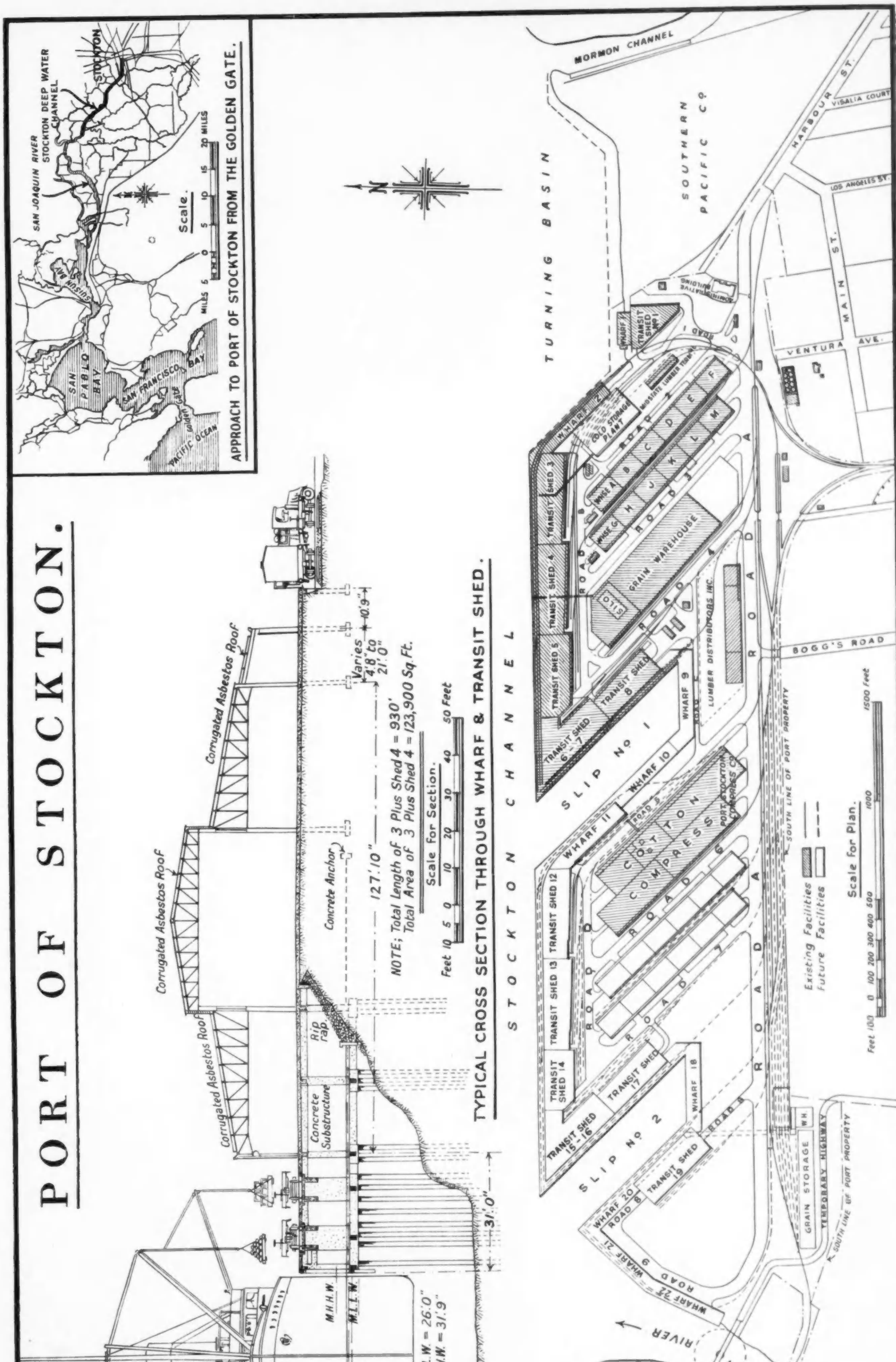
The structures rest on an 8-ft. dredge fill superimposed upon the natural soil. This is of a fairly good sandy consistency, and not very susceptible to flow. Timber piling is used cut off below low water, capped with concrete and a beam and column reinforced concrete structure erected thereon.

The rear piling serve as substantial anchorage to the structure, but in order to supplement that, approximately at 50-ft. intervals, reinforced concrete deadmen have been cast in place connected with the wharf structure by 2-in. galvanised rods as a further precaution.

In the treatment of the bank itself, it is allowed to assume a natural slope, and is covered with rip rap, the toe of which is held in place by a small wave-wash bulkhead, and surcharge is reduced to a minimum.

No piles have been used under that portion of structure which rests on the land, spread footings being employed under columns, reaching down to the original elevation of the soil.

Interior of Transit Shed.


PORT OF STOCKTON.
APPROACH TO PORT OF STOCKTON FROM THE GOLDEN GATE.
SAN JOAQUIN RIVER
STOCKTON DEEP WATER CHANNEL
STOCKTON
SUISUN BAY
SAN PABLO BAY
SAN FRANCISCO BAY
Golden Gate
PACIFIC OCEAN
Scale.
MILES 5 0 5 10 15 20 MILES
TYPICAL CROSS SECTION THROUGH WHARF & TRANSIT SHED.
Corrugated Asbestos Roof
Corrugated Asbestos Roof
Corrugated Asbestos Roof
Concrete Anchor
Rip rap.
Concrete Substructure
M.H.H.W.
M.L.L.W.
Depth at M.L.L.W. = 26'0"
Depth „ M.H.H.W. = 31'9"
31'0"
127'10"
Varies 4'8" to 21'0"
10'9"
NOTE; Total Length of 3 Plus Shed 4 = 930'
Total Area of 3 Plus Shed 4 = 123,900 Sq. Ft.
Scale for Section.
Feet 10 5 0 10 20 30 40 50 Feet
MORMON CHANNEL
TURNING BASIN
SOUTHERN PACIFIC Co
STOCKTON CHANNEL
SLIP No 1
SLIP No 2
SAN JOAQUIN RIVER
HARBOUR ST.
VISALIA COURT
LOS ANGELES ST.
MAIN ST.
VENTURA AVE.
BOGG'S ROAD
ADMINISTRATION BUILDING
TRANSIT SHED No 1
WHARF 1
WHARF 2
COLD STORAGE PLANT
TRANSIT SHED 3
TRANSIT SHED 4
TRANSIT SHED 5
TRANSIT SHED 6-7
TRANSIT SHED 8
WHARF 9
WHARF 10
WHARF 11
TRANSIT SHED 12
TRANSIT SHED 13
TRANSIT SHED 14
TRANSIT SHED 15-16
TRANSIT SHED 17
WHARF 18
TRANSIT SHED 19
WHARF 20
WHARF 21
WHARF 22
GRAIN WAREHOUSE
SILO
LUMBER DISTRIBUTORS INC.
COTTON COMPRESS
PORT STOCKTON COMPRESS Co
GRAIN STORAGE
W.H.
TEMPORARY HIGHWAY
SOUTH LINE OF PORT PROPERTY
ROAD
Existing Facilities
Future Facilities
Scale for Plan.
Feet 100 0 100 200 300 400 500 1000 1500 Feet

Port of Stockton, California—continued

Aerial View of Port Terminal.

The wharf structure resting on piling is 77-ft. wide. The piling supporting this structure is cut off 6-in. above mean lower low water level (elevation 2.5) and is embedded 6-in. into a 27-in. thick reinforced concrete cap supporting floor columns. These concrete caps are tied together with 12-in. by 24-in. precast reinforced concrete beams set in place before pouring of the caps. All concrete in this portion of the structure was poured at the lower levels of the tide. No pouring was done when a water depth of over 8-in. existed in the forms. Forms were made reasonably tight and practically no cement was lost in the pouring operations.

Pre-casting of tie beams and exercising care in hanging and constructing the forms for the pile caps eliminated the necessity of constructing coffer dams for the execution of this portion of the work.

The entire wharf structure was designed for a live load of 500 lbs. per sq. ft. except where railroad tracks were located, Footings, beams, and piers supporting the railroad tracks were designed for a Cooper-E-50 loading. A six-rack concrete was specified for all pile caps, tie beams and columns in the wharf structure. All other reinforced construction was specified as a 2,000 lb. concrete. Concrete in the floor slab over the earth fill was specified as a 1,500 lb. concrete.

Shed Construction and Rail Facilities

The floor slabs in the transit sheds resting on the earth fill are composed of a 6-in. concrete base with a 2-in. asphalt topping. To provide for settlement of this front area adjacent to the wharf structure, the floor was laid 2-in. high, in order that later, if necessary, it might be equalised through the addition of asphalt to the surface of the settled area.

As stated above, the railroad facilities along the face of the dock consist of two parallel tracks. The rails for these tracks are 128-ft. girder sections set in concrete. Switches and crossovers as well as trestle tracks are of 85 lb. Tee rail. The tops of all rails are set flush with the level of the wharf. The tracks at the rear of the building are set 4-ft. below the loading platform provided along these sides of the sheds. This brings the car floor level to the same elevation as platform level, facilitating loading and unloading of cars. The area between these tracks is gravelled to the same elevation as the rail grade, making it possible for trucks to load and unload at this same point. Second-hand 85 lb. Tee rail was used on all land side tracks.

Numerous doorways have been provided on both sides of the transit sheds to permit ingress and egress from the buildings with maximum ease. All the doors facing the water are of the steel rolling type with a width of 14-ft. and a maximum vertical clearance of 13-ft. All doors on the land side are of the sliding type with vartical opening of 10-ft. and horizontal opening of 14-ft. These are constructed of non-resinous wood core with metal covering. All fire wall door and end door openings have a vertical clearance of 15-ft., and a horizontal opening of 16-ft. This provides ample clearance for all possible motor truck loadings. All firewall openings are equipped with approved fire doors.

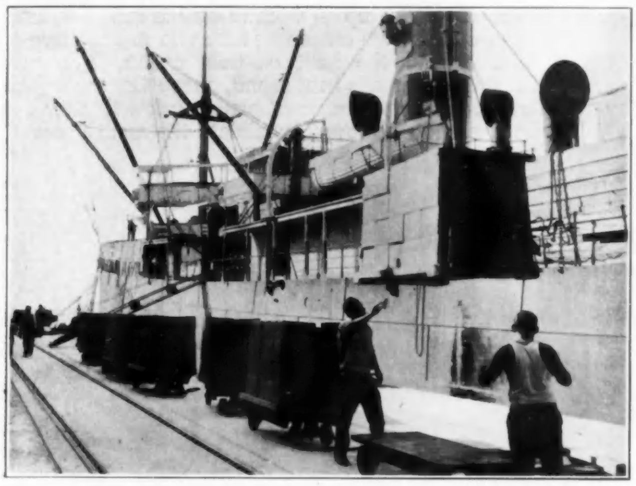
In the original transit shed construction, the sheds were ventilated through a system of louvres placed in the side of the monitor. Some difficulty was experienced, during periods of driving rain, in keeping moisture from entering the sheds at this point, and consequently in the new sheds the louvres were eliminated and Multi-vane Turbine type ventilators were placed on the ridge of the buildings. These are proving quite satisfactory and lend a pleasing finish to the roof line. Some trouble has also been experienced in maintaining a water-tight roof in the original sheds which were covered with corrugated asbestos. It was deemed advisable to adopt a different roof specification. It was, accordingly, decided to use a treble thickness of 35 lb. roofing paper on one layer of resin sized sheathing laid on a 2-in. T and G wooden deck; 90 lbs. of asphalt and 300 lbs. of gravel per square were used in the application. To improve lighting conditions, the under-side of the roof was sprayed with washable kalsomine.

Office Accommodation.

6,000 sq. feet of office space was provided in a second floor arrangement in Transit Shed No. 6. In this space are located the general offices of the Stockton Port District, including the office of the Director of the Port, office of the Port Commission, Operating Department, Traffic Department, Financial Department, and Engineering Department. These offices were designed with the idea of providing a maximum of comfort over the range of temperatures encountered during summer and winter conditions. All walls and ceilings are faced with 1-in. thick Firtex. Floors are of wood 4-in. thick covered with linoleum. Heat is provided by steam distributed through a combination of radiators and unit heaters. A cooling system is also provided, taking air from under the wharf.

Port of Stockton, California—continued

The elevation of the face of the finished dock is 18.0 U.S.E.D. Low water level in the stream is approximately 2.5. Considerable freight is hauled to these wharves by small shallow draft boats. To facilitate the unloading of freight from these craft on to the docks three freight elevators have been provided in this development. One was placed in Shed No. 5 and two in Shed No. 8. Each of these has a lifting capacity of 20,000 lbs. at a minimum speed of 35-ft. per minute. Each elevator has a platform area of approximately 144 sq. ft. All machines are equipped with automatic stops top and bottom and are operated by push-button control. They are equipped with all safety devices required by federal and state laws. The lower loading platform for these elevators is placed at an elevation slightly above the high tide level. This insures the possibility of being able to operate these machines during the full range of tidal change.



Shipping Canned Goods on board ss. "Calmar."

Finally, the construction as carried forward up to the present time has furnished the largest ship-side terminal on the Pacific Coast, which, operating as a single unit, has the following characteristics:—

Berthing capacity, 8 steamers.
Lineal berthing of wharf, 3,392-ft.
Open wharf area, 131,872 sq. ft.
Total area under cover, 957,090 sq. ft. or 21.9 acres.
Paved open storage area, 10.2 acres.
Approximate cost of structure, $2,500,000.
Depth of water, 32-ft.
Warehouses, 182,400 sq. ft.

Regulations for the Handling of Petroleum in Harbours

Measures for Port Protection

The following is the text of the Petroleum Spirit in Harbours Order recently made by the Minister of Transport:—

In pursuance of Regulation 76 of the Defence Regulations, 1939, the Minister of Transport hereby makes the following Order:—

Notwithstanding any restriction imposed by or under any Act in relation to the shipping, unshipping, handling, storage or conveyance of ammunition explosives or inflammable substances, the following provisions shall apply to the loading and unloading, storage and conveyance of petroleum spirit within all harbours in the United Kingdom.

The representative of the Owner shall give due notice to the Harbour Master of the arrival of a petroleum ship and as soon as practicable of the quantity of petroleum spirit on the petroleum ship and of the manner in which it is stowed.

Before any petroleum spirit is brought into a harbour for shipment, or is transhipped from one petroleum ship to another petroleum ship in the harbour, or is loaded into or unloaded from any petroleum ship, the representative of the owner concerned shall give due notice to the Harbour Master of the time when and the place where it is intended to carry out such transhipment, loading or unloading. In selecting a place for the purpose of the loading or unloading of petroleum spirit the representative of the owner shall consult the Harbour Master and take all due precautions for the safety of the harbour. Provided that if owing to urgency, it is impracticable to give prior notice to the Harbour Master, notice shall be given at the first available opportunity.

All petroleum ships in any harbour shall display by day a red flag with a white circular centre and by night a red light at the masthead, or where it can be best seen but not less than 20-ft. above the deck, in addition to any navigation lights which may be required by any other Regulations.

A representative (hereinafter called the "Officer in charge") appointed by the owner and specially charged with the supervision of the loading and unloading of petroleum spirit, shall be present during the whole of the time of such loading and unloading, and until the holds and tanks of the petroleum ship being loaded or unloaded shall have been securely closed.

Before any petroleum spirit contained in cans, casks, barrels or other containers is unloaded, the holds of the petroleum ship having on board such containers shall be thoroughly ventilated, and after all petroleum spirit has been removed from any such petroleum ship, the holds and tanks shall be rendered free from inflammable vapour. This requirement shall not apply to the tanks of a petroleum ship which leaves the harbour without delay after the discharge of petroleum spirit or remains only for the purpose of taking on board, bunkers, stores or ballast and of which the tanks are closed down immediately after the discharge of such petroleum spirit.

Iron or steel tools or other instruments capable of causing a spark shall not be used for the purpose of opening or closing the hatches or tank lids of a petroleum ship.

Two or more petroleum ships shall not, except for the purpose of transhipment, lie within 100-ft. of one another, unless it is impracticable to maintain such distance.

Petroleum spirit contained in defective containers shall not be loaded into a petroleum ship in the harbour, and any petroleum spirit contained in such defective containers shall be placed aside, together with the container in a safe place and instructions given for disposal thereof by the Officer in charge.

All petroleum ship and shore fire-fighting appliances capable of extinguishing a petroleum spirit fire shall be kept ready during the operation of loading and unloading petroleum spirit.

Every petroleum ship shall be watched by a competent person on board such ship until all petroleum spirit shall have been landed or loaded and the holds or tanks securely closed.

In this Order (1) the expressions "Harbour Authority," "Harbour," "Petroleum Spirit," and "Ship" shall have the meanings respectively assigned to them in the Petroleum (Consolidation) Act, 1928; (2) "Harbour Master" shall mean the Harbour Master or other Officer having authority to act in such capacity; (3) "Owner" shall mean the owner or Master of a petroleum ship or the owner of the petroleum spirit as the case may be; (4) "Petroleum Ship" shall mean any ship having on board or about to take on board a cargo the whole or any part of which consists of petroleum spirit or having discharged petroleum spirit if the holds and tanks have not been rendered free from inflammable vapour.

This Order may be cited as the Petroleum Spirit in Harbours Order, 1939.

The Chamber of Shipping

Annual Report for the Year 1938-39

The recently issued Report of the Chamber of Shipping of the United Kingdom for the year 1938-39, contains the usual valuable compendium of information and statistics relating to the British Shipping Industry. The greater part of it lies outside the sphere of this Journal, but the following extract on Dock Dues and Charges is germane to port affairs.

In the main, states the Report, there has been no material change in the level of dock dues and charges at U.K. ports. Through the Traders' Co-ordinating Committee on Dock Charges, agreement was reached with the Southern Railway Company for small increases in certain rates chiefly affecting merchants at Southampton Docks. These, and modifications at a few other ports recorded by the Chamber since the issue of its last annual report, were again made largely to meet higher labour costs and/or increases in the prices of materials. As being unsound in principle, and prejudicial to coastal shipping, support has been given to steps taken by local interests for the abolition of certain dues levied at Dover on coals brought in by sea, but not by rail, the revenue from which is used other than for port purposes.

There is also a reference to Pilotage and a statement of the attitude of the Chamber towards a pronounced tendency on the part of pilots to press for changes in the method of levying pilotage dues, it being emphasised that the distribution of the cost of pilotage among the several classes of shipping using a port is primarily a matter for the shipowners concerned. A claim for the adoption of compulsory pilotage in the Newcastle-on-Tyne district is deprecated in the absence of any changed circumstances which, on grounds of safety, might justify the claim.

Schemes of Improvement for the Cheshire Dee

An Investigation by Means of Model-Experiments*

By JACK ALLEN, M.Sc., Assoc. M. Inst. C.E.

INTRODUCTION.

THE investigation described in this Paper was carried out on behalf of the River Dee Catchment Board. Its object was to study means of improving the drainage and the navigable qualities of the River Dee.

The primary trouble with this river is the continual tendency for bed material to be transported upstream by the flood tide, which, at Connah's Quay, occupies a time of the order of 2 hours only, as compared with 10 hours or so of ebb. A secondary, but very important, factor is the marked instability of the channel seawara of Connah's Quay. This channel is tortuous, shallow, and subject to great fluctuations in its position and configuration.

At the present time, there are in existence two training walls (Figs. 1). One of these, AA_1, which will be referred to as the South wall, is covered at high water, its crest-level being some 21-ft. above Liverpool Bay datum†

The other wall, which will be called the North Wall, is above high water of spring tides over its length BB_1, and has a crest-level over its remaining portion, B_1B_2, averaging 22.00 L.B.D.

For many years, it has been thought that conditions might be improved by extending these walls, whilst the suggestion has also been advanced that a barrage situated near Connah's Quay might be used to scour the channel downstream and to prevent the travel of material upstream.

The points to be investigated may, therefore, be summarised as follows:—

(1) Are the existing walls beneficial?

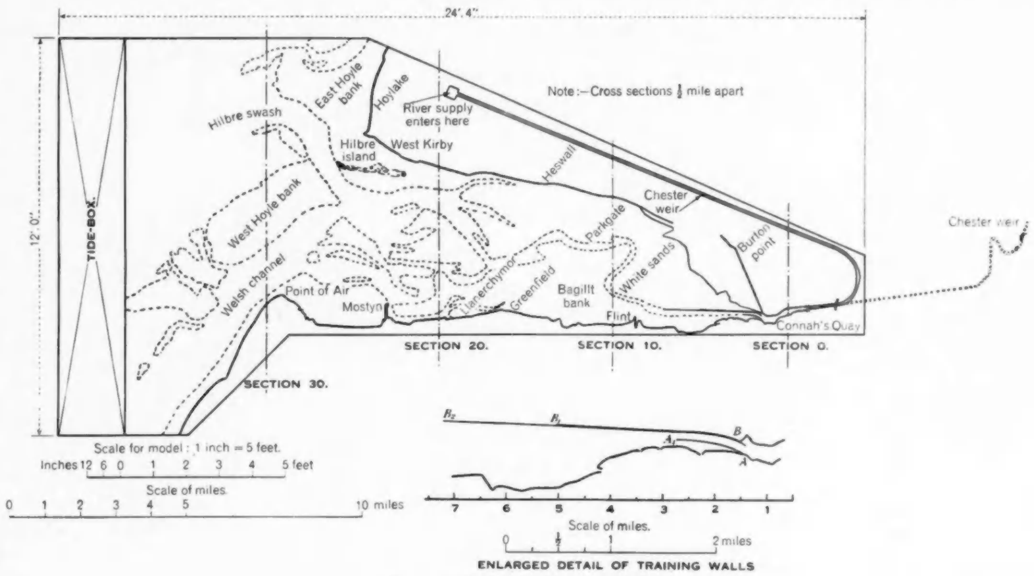
(2) Could they be improved by altering their crest-levels?

(3) Would an extension be desirable, and, if so, along what line?

(4) Is a barrage, equipped with locks and sluices, likely to effect an improvement?

Following the general tendency of modern practice, it was decided to study the problem by means of scale models, and accordingly two models have been constructed and operated in the Whitworth Laboratory at Manchester University, under the direction of Professor A. H. Gibson, M.Inst.C.E.

The major of these models has scales of 1:5,000 horizontal and 1:200 vertical. Its tidal period, corresponding to these scales, is 126.4 seconds, equivalent to 12.4 hours in nature, so that 1 year of tides occupies approximately 24 hours. The scope of the model is shown in Figs. 1, from which it will be seen that, in addition to the great expanse of sands from Liverpool Bay (seaward of Hilbre Island) to Connah's Quay, the canalised portion of the River Dee up to Chester weir is included, along with a portion of the river extending for some miles above the weir, in fact beyond the limit of tidal action. For space considerations, the river was bent round, above Connah's Quay, by a gentle curve joining the straight portion below Chester weir. This device does not, however, invalidate the model over the region upstream of Connah's Quay, observation showing that the general behaviour is similar to that in nature. For instance, the tide-levels obtained at Chester weir relative to Connah's Quay are in virtually perfect agreement, as is the phenomenon of the bore which appears at spring tides‡ Moreover, it has been the general practice to run pairs of comparative tests in the model; that is, to test a proposed scheme of works by operating with and without that scheme from a standard initial condition of the bed.



Figs. 1. Plan of Major Model.

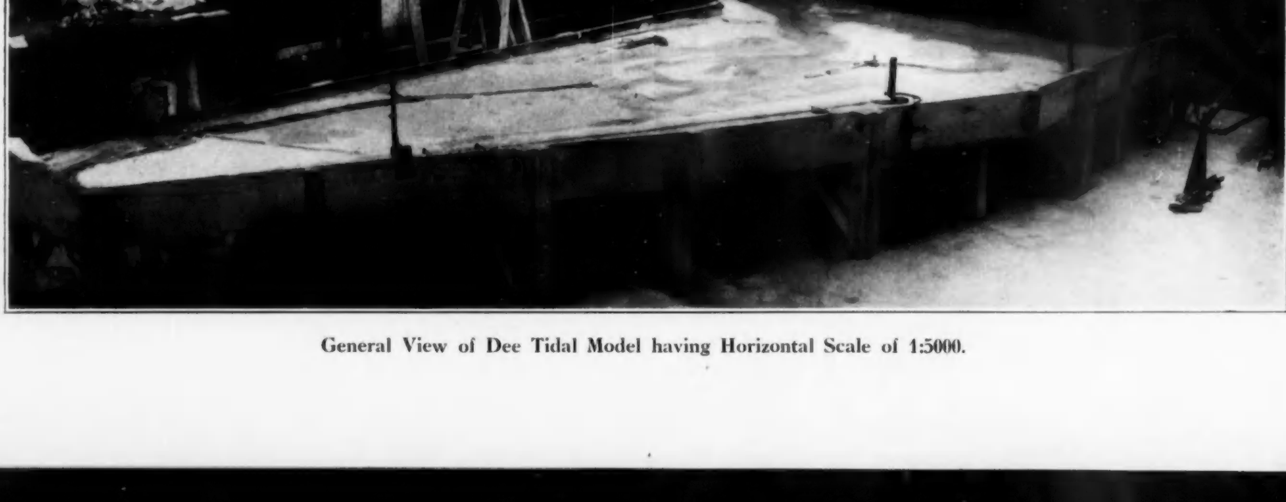
River water is admitted at the upper end of the model through one of a series of calibrated orifices, so arranged as to give any flow up to that of a flood equivalent to 7,500 cusecs.

For the purpose of the tests, the mean flow has been taken as 1.070 cusecs: this will be designated a " normal " river.

*Paper read before the Institution of Civil Engineers, on 4th April, 1939, and reproduced by permission from the Institution Journal.

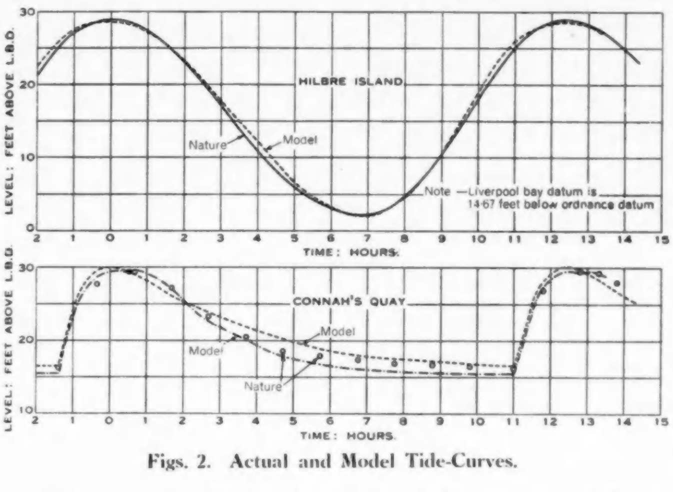
†Liverpool Bay datum is 14.67 feet below O.D.

‡The bore has been discussed in some detail in a previous Paper by the Author: "Experiments on Water Waves of Translation in Small Channels." Phil. Mag., Series 7, vol. xxv. (1938), p. 754.



General View of Dee Tidal Model having Horizontal Scale of 1:5000.

Schemes of Improvement for the Cheshire Dee—continued



Figs. 2. Actual and Model Tide-Curves.

Tides are produced by the displacement of a steel plunger situated at the seaward end of the model and driven through an epicyclic train of gear wheels by a constant speed motor. The epicyclic gearing automatically varies the stroke of the plunger from a maximum at spring tides to a minimum (fourteen tides later) at neaps, and back to a maximum, in a further fourteen tides, for the next springs.

The crank-pin attached to the last wheel of the epicyclic train rotates in a brass block which itself slides along a slotted bar. This bar, pivoted at one end, serves to produce a longer time of rise for the plunger than fall, or a longer ebb than flood, as is demanded by the shape of the tide-curve in Liverpool Bay.

The varying thrust of water on the plunger is balanced by means of a weight suspended from a cam of appropriate shape.

The bed-material used to form the sand banks in the model is a sand having a mean grain size of 0.0071-in. and a mean ratio of longest to shortest diameters for its individual grains of 1.53. In certain tests, however, comparative results were obtained with a coarser sand (mean diameter 0.0092-in., mean ratio 1.58) in others, with powdered pumice (mean diameter 0.0115-in., ratio of longest to shortest diameters of individual grains 1.58). The specific gravity of the sand was 2.63, and of the pumice 2.00.

Since the river water of the Dee is, for practical purposes, clear, no silt in suspension was supplied in the river water of the model.

The other tidal model used in this investigation has scales of 1:40,000 horizontal and 1:400 vertical, its tidal period therefore being 22.3 seconds. Although this model is only some 4-ft. in length, it has proved to be of considerable assistance. Tidal heights are found to be reproduced in it with considerable accuracy, the same principle of displacement by a plunger being adopted as in the large model. Preliminary experiments made in the small model provided a useful guide as to schemes which might profitably be tried on the major model, and indeed the effect on tidal phenomena of various training walls was sensibly the same in to the two models. It is to be understood, therefore, that although the experiments described in this Paper were made, unless specifically stated to the contrary, on the larger model, at the same time many of the results were confirmed by the smaller model. Further, no material discrepancy appeared in the conclusions reached from the two models during any of the tests, which were carried out in both models.

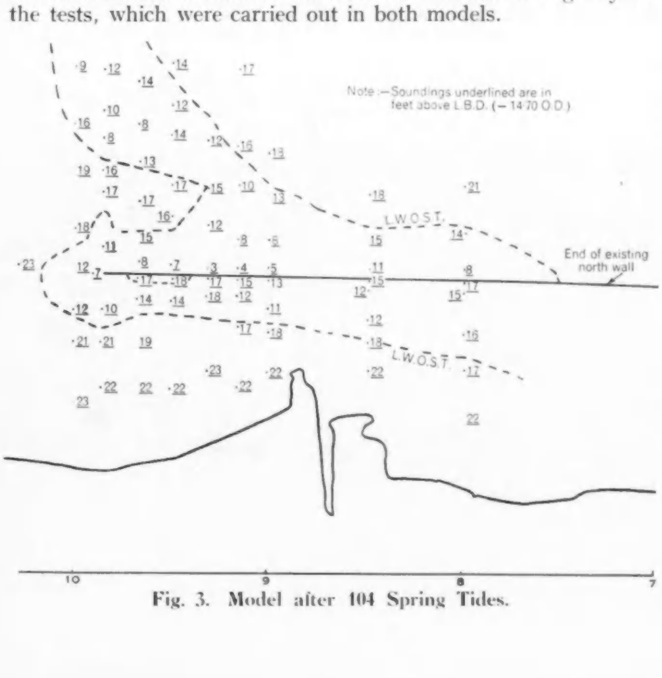


Fig. 3. Model after 104 Spring Tides.

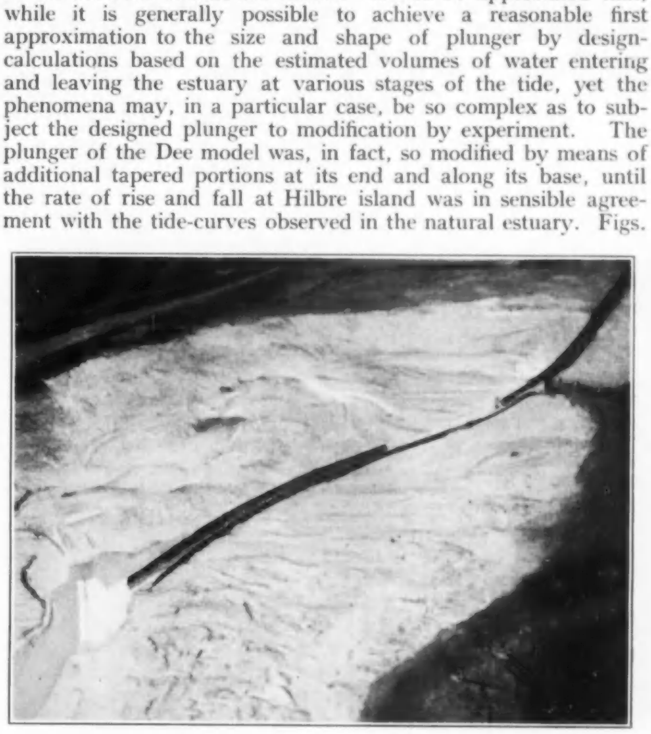
Tide-levels in the larger model were read chiefly by means of pointer gauges equipped with verniers reading directly to 0.01-in., but partly on graduated scales supported by suitable brackets. Measurements of tide-levels in the smaller model were, however, facilitated by pointer gauges attached to micrometer screws with verniers capable of a direct reading to 0.001-in.

The methods adopted for moulding and surveying were as described by Professor Gibson in the Vernon-Harcourt Lecture, 1935-36*

THE INVESTIGATION.

Preliminary.

Existing charts of the Dee were supplemented by a series of aerial photographs taken at L.W.O.S.T. on the 21st June, 1937. These photographs were resolved into a scale plan of the low-water channels, through a method devised by a colleague of the Author's, Mr. J. L. Matheson, M.Sc., Assoc., M.Inst.C.E., and described by him in a Paper already published by The Institution†. The bed of the model having been moulded to agree with available information, the first tests were devoted to the adjustment of the plunger in order to generate the correct tide at the seaward end of the model. It will be appreciated that, while it is generally possible to achieve a reasonable first approximation to the size and shape of plunger by design-calculations based on the estimated volumes of water entering and leaving the estuary at various stages of the tide, yet the phenomena may, in a particular case, be so complex as to subject the designed plunger to modification by experiment. The plunger of the Dee model was, in fact, so modified by means of additional tapered portions at its end and along its base, until the rate of rise and fall at Hilbre island was in sensible agreement with the tide-curves observed in the natural estuary. Figs.



Scheme "E," after 3.76 years.
(Before closing the gap in the North wall between Sections 9 and 11).

2 demonstrate the agreement obtained. A comparison of the tide-curves at Connah's Quay in the natural estuary and in the model is not so readily obtained. In the first place, the rate of rise of the tide at Connah's Quay, in nature, is known to vary considerably from time to time, according to the configuration of the estuary, the state of the river, and the prevailing meteorological conditions. Thus, in discussing a Paper read by Mr. F. Webster, M.C., M. Eng., Assoc. M. Inst.C.E., before the Liverpool Engineering Society in November, 1929, Mr. A. Caradoc Williams, Assoc. M.Inst.C.E., stated that "the flow at Connah's Quay lasts for a period of from 2 hours 15 minutes down to 1 hour 50 minutes. . . . During neap-tides there may be no rise at all at Chester, and in one case recently there was only a 3-ft. rise at Connah's Quay." (The neap-range at Connah's Quay is frequently 7.5-ft., and at Chester weir 2.5-ft.).

The model, in fact, reveals the interesting phenomenon that high-water level at Connah's Quay, for a given tide at Hilbre, depends essentially upon the level of the Bagillt bank. By lowering this bank it is readily possible to raise high-water level at Connah's Quay by as much as 17-in.

In Figs. 2 it will be observed that two tide-curves are shown, taken at different times and with different low-water levels, at Connah's Quay in the model, whilst, for comparison, an estuary-curve for the same place is also given.

The comparison thus afforded appears to justify the conclusion that the tide at Connah's Quay is sufficiently well represented in the model, if not in fact, that were it practicable to

*"Tidal and River Models." Journal Inst. C.E., vol. 3 (1935-36), p. 699. (October Supplement, 1936).

†"An Aerial Survey of the Estuary of the River Dee, Employing a Simple Method of Rectifying Oblique Photographs." Journal Inst.C.E., vol. 10 (1938-39), p. 47. (November, 1938).

Schemes of Improvement for the Cheshire Dee—continued

reproduce in the model the identical conditions obtaining at the time of any particular observations made in the natural estuary, the agreement would be within the limits of observation.

It is interesting to note also that low-water level at Connah's Quay is somewhat lower, in the model, at neaps than at springs (for a given river-discharge), and tnis phenomenon is believed to be in agreement with nature.

A series of tests was next made to study the effect of various modifications of the existing training walls on the spring-tide levels of high water and the times of ebb and flood at Connah's Quay and Chester Weir. It was assumed that any alteration which prolongs the flood and shortens the duration of the ebb-tide will tend to improve the condition of the river between Connah's Quay and Chester. Since, however, almost the whole of the movement of the bed occurs during the first half of the flood and the second half of the ebb, observations were made of these times also. Twenty experiments were carried out on these lines, care being taken to adjust the moulding of the bed from time to time so as to preserve comparable conditions. In particular, the level of low water was kept constant.

These tests showed that any changes in the North wall alone, whether in the way of lengthening or shortening or of raising or lowering, are, on the whole, detrimental. For example, raising the North wall above high water throughout its length reduced the time taken by the first half of the flood-tide by some 6%; high water at Connah's Quay was raised 0.1-ft. Removing the low part of the North wall raised high water at Connah's Quay by 0.3-ft., and high water at Chester Weir by 0.1-ft., at the same time reducing the time of the first half of the flood at Connah's Quay by as much as 25%.

Raising the South wall above high-water level, however, showed a definite gain, especially when such a raised wall was also extended to a point opposite the end of the high part of the North wall. This latter scheme had the effect of increasing the time of half flood at Connah's Quay by 30, 25 and 16%, according to whether "no river," "normal river," or "flood river" respectively was in operation. At the same time, high-water levels at Connah's Quay and Chester Weir were lowered some 4-in., an effect which, from the point of view of drainage, would be beneficial. Moreover, the scouring effect of the ebb-tide was improved, since the time of the last eighth of the ebb at Connah's Quay was reduced by 5, 1 and 10%, for no river, normal river, and flood river respectively.

A slight additional improvement might be effected by extending the South wall, as a half-tide wall, to the end of the present low North wall, but the gain would not appear to justify the extra cost.

When the existing training walls were taken out of the model, high-water levels at Connah's Quay and Chester Weir rose 6 and 5-in. respectively; the time of the first half of the flood at Connah's Quay was reduced by 37%. It is established, therefore, that the existing walls are of value from the point of view of drainage and of decreasing the volume of bed-material transported upstream.

Schemes for Opening a Channel through the Bagillt Bank

(a) The North wall being extended in stages for a distance of approximately 1¼ mile did not lead to the formation of a channel through the Bagillt Bank. The scour was felt for a distance of about 400-ft. beyond the toe of the wall, but the ebb then doubled back behind the wall to find its way into the existing channel. Again it was found that more material was carried upstream on the flood than was ultimately removed by ebb-scour. For this reason, the low-water level at Connah's Quay rose 3.3-ft. during a run of a hundred spring tides, at the end of which the configuration of the channel was as shown in Fig. 3. Substantially the same results were obtained using a bed-material of powdered pumice, and again with a coarser grade of sand.

(b) Even with a South wall extended above high-water level as far as the end of the existing high North wall, and the North wall continued as far as Section 11 (that is, 2 miles beyond its present limit), a channel was not produced through the Bagillt Bank. This statement applies whether the North wall is extended as a low or a high wall. During a run of three

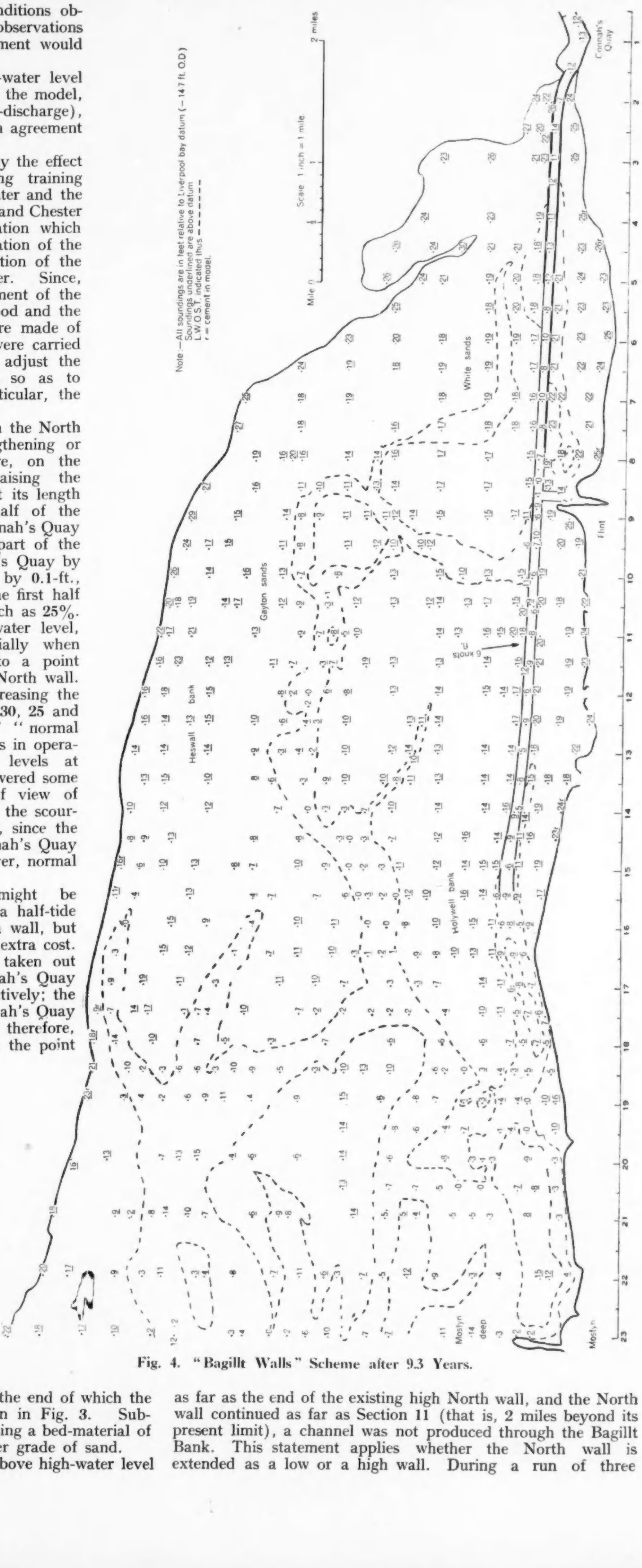


Fig. 4. "Bagillt Walls" Scheme after 9.3 Years.

Schemes of Improvement for the Cheshire Dee—continued

hundred and eighty-nine spring tides with a high extended North wall, low water at Connah's Quay rose 2.3-ft., high water fell 1.6-ft., and at Chester Weir high water fell 1.0-ft.

(c) With the North wall extended to Section II. and a channel dredged through the Bagillt Bank alongside the wall and beyond it, to join the existing channel at Llanerchymor, it was found that the channel deteriorated. In particular, the dredged channel seaward of the end of the wall showed a marked tendency to diverge from the straight and to scour to the southward.

(d) The next test was carried out to determine whether, with the estuary and training walls in their present state, a straight channel dredged through the Bagillt Bank would be maintained. This dredged channel had a bottom width of 200-ft., was in a line forming a prolongation of the existing trained channel, had a bed-level of 14.00 L.B.D., and involved the excavation of 1.3 million cubic yards. The dredged channel was found to deteriorate rapidly, even when the North wall was extended at half-tide level as far as Section 10½.

(e) Tests were also made, with the full spring-neap cycle of tides, on a completely trained channel through the Bagillt Bank, bounded by two walls in the form of a continuation of the existing walls as far as Section 15½. This amounted to extending the North wall 7,000 yards and the South wall 11,000 yards. The width between the walls varied from 410-ft. off Flint to 750-ft. at the mouth of the walls. A channel was dredged between the walls to give the same low-water level as with the existing channel, and it was found that high water at Connah's Quay was lowered by 0.7-ft., while the rate of rise of the tide there was very considerably reduced.

Unfortunately, however a strong ebb-current (about 7.4 knots) was created, impinging on the foreshore seaward of the walls and resulting in pronounced scour, the scoured material being deposited in the lower channels.

A strong cross current occurred, around spring tides, sweeping over the tops of the walls, almost normal to the trained channel, between Sections 5 and 9. Not only is this objectionable from the point of view of navigation, but it caused a scour to a depth of between 10 and 14-ft. behind the South wall in the region of Sections 5½ and 8½. This scoured material was carried upstream behind the walls as far as Section 4, where the greater portion of it was swept over the South wall and deposited in the channel, causing a shoaling of as much as 6-ft. in 1 year of tides.

In order to prevent this action, it was found necessary to raise the South wall to high-water level everywhere upstream of Section 8, after which some 680,000 cubic yards of sand were dredged from the channel between Connah's Quay and Flint. As a result of this dredging, low water at Connah's Quay was observed to be 16.10 L.B.D. During a further 4.75 years of tides, however, the channel again deteriorated to such an extent that low water at Connah's Quay was found to be 17.40 L.B.D., and an additional 715,000 cubic yards had to be removed from the bed of the channel in order to restore the low-water level.

A gap was next made in the South wall opposite Flint Tips. The width of the gap was 420-ft., and a channel was dredged between it and Flint and revetted with walls having a crest-level of 16.00 L.B.D. It was found, however, that, about 1.55 hour after the beginning of the flood at the mouth of the walls, a strong cross current of as much as 5 knots swept diagonally across the gap.

After running for a total period of 9.3 years, a survey was taken, and is shown in Fig. 4. For comparison, the initial condition of the bed is shown in Fig. 5. During the experiment, there was considerable deterioration of the channel between the mouth of the walls and the Mostyn Deeps. An appreciable bore was observed to travel up the trained channel on the flood of spring tides.

Following the 9.3-year survey, the channel between the walls was again dredged and a low-water level of 15.40 L.B.D. obtained at Connah's Quay. Detailed observations of currents were then made and revealed the persistence of flood-tide cross currents proceeding towards the Welsh coast, at right angles to the walls, over the whole length of the North wall. These currents were especially evident in the region of Sections 9 and

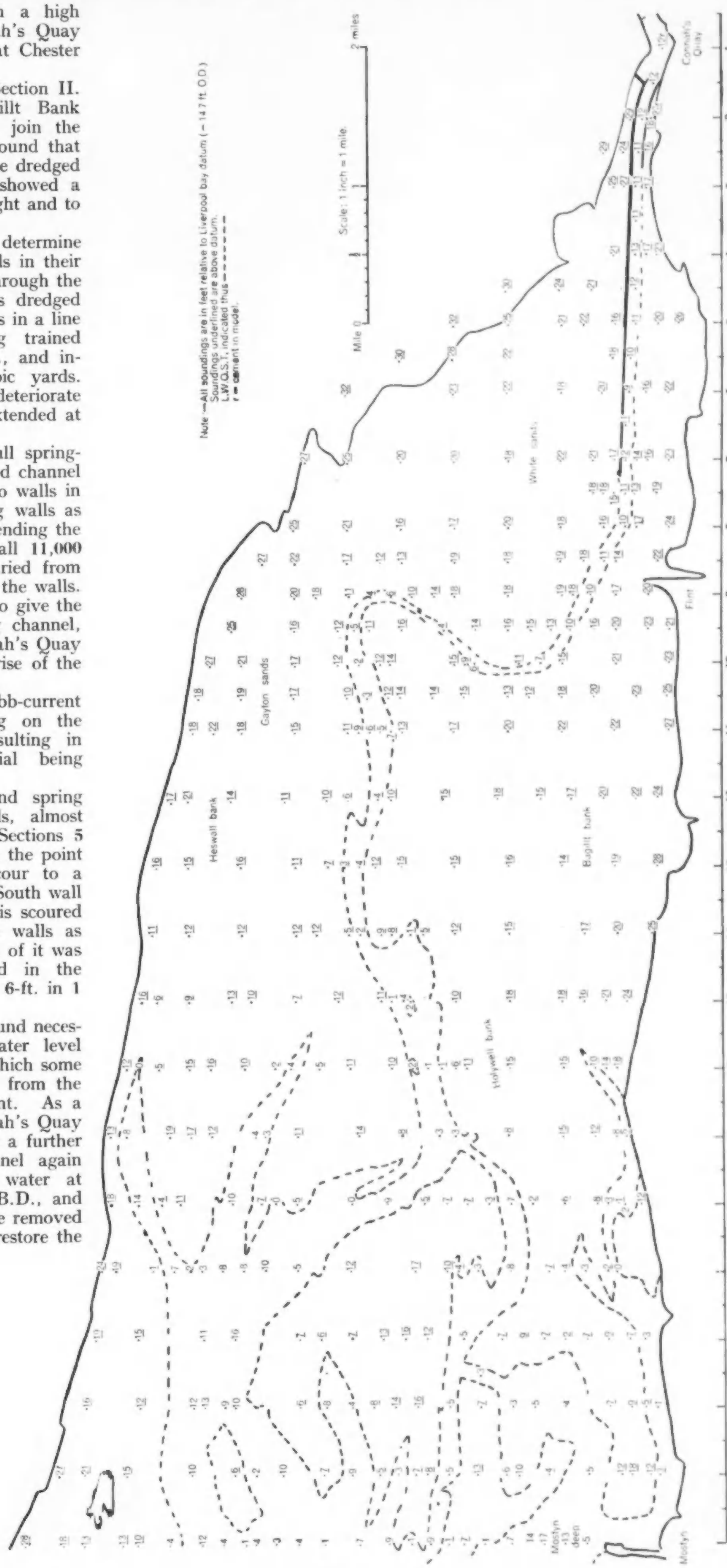
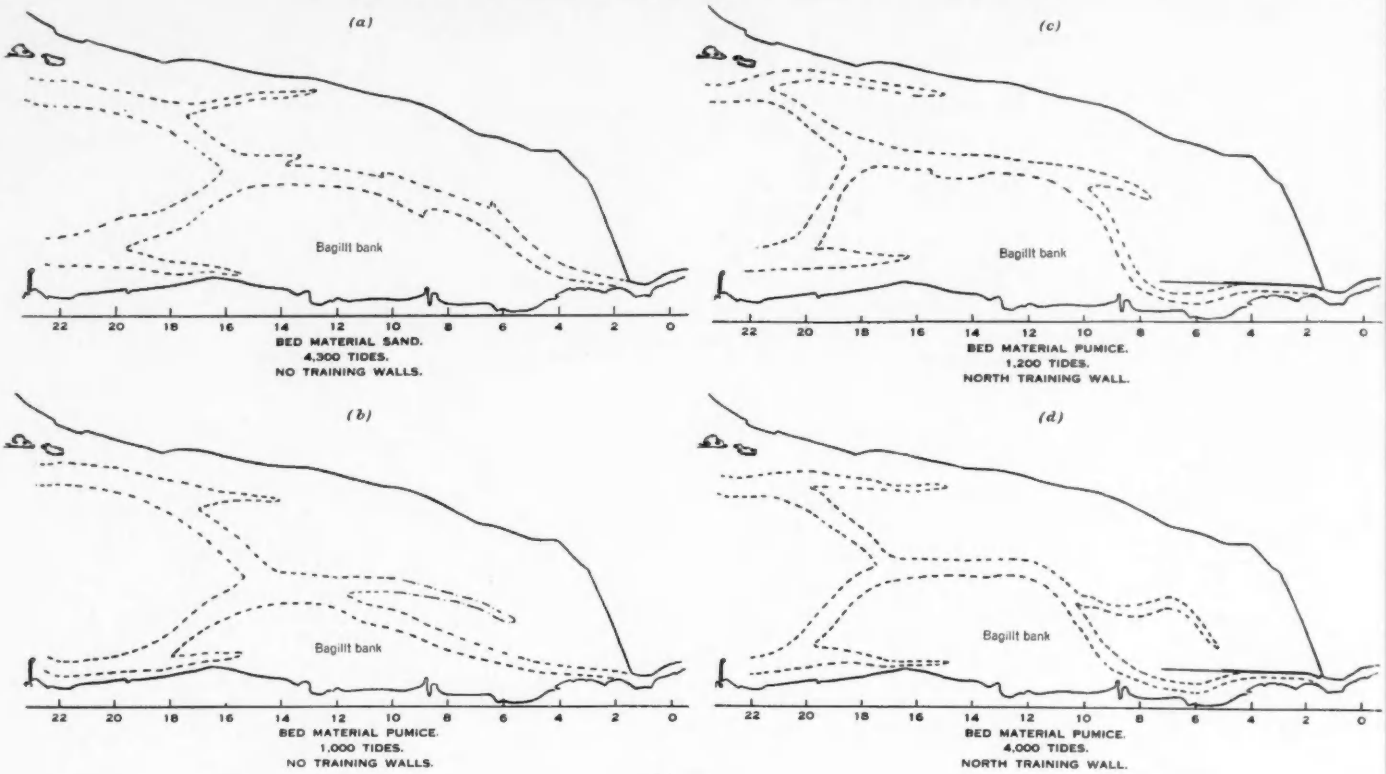


Fig. 5. Initial Condition of River.

Schemes of Improvement for the Cheshire Dee—continued



Figs. 6.

12, where they attained a speed of 6 knots. It was clear, therefore, that in order to facilitate navigation it would be necessary to raise the North wall above high-water level almost throughout its length, and whilst this device was studied in some detail, the scheme of a trained channel through the Bagillt Bank could not be freed of certain inherent faults, viz.:

(1) The amount of dredging to establish and maintain a navigable channel is large.
(2) The channel, being straight, is essentially less stable than a curved channel.
(3) The ebb-current seaward of the toe of the walls is rapid and would erode any foreshore not heavily protected.
(4) The approach to the mouth of the walls from the Hilbre side of the estuary is difficult.

(f) Tests on the smaller model with bed initially level. In order to determine what sort of configuration of sand-banks would be produced by the action of the tides if the bed of the estuary were initially level, four experiments, one with sand and three with pumice as bed-material were carried out on the smaller model. For two of these tests, one with sand and one with pumice, all training walls were removed; in the other tests, a wall representing the existing North wall was introduced. The results are shown in Figs. 6.

They are of interest in demonstrating that, without training walls, the main channel tended to make towards the Wirral side of the estuary; nor did the introduction of the training wall materially affect this tendency beyond the toe of the wall.

In every case the Bagillt Bank was developed as a prominent feature of the estuary. It is produced partly by the direct transportation of the flood-current and partly by an eddy contained in the flood-tide and making towards the Welsh shore.

(To be continued)

Mobile Port Labour

Formation of Voluntary Corps of Dockers

It is announced that an agreement has been concluded between the Minister of Labour and National Service on behalf of H.M. Government, the National Council of Port Labour Employers, the Transport and General Workers' Union, on its own behalf and on behalf of the unions associated with it, namely, the National Union of General and Municipal Workers and the National Amalgamated Stevedores and Dockers, which has for its object provision for the temporary transfer, on a voluntary basis, of dock labour in war time with a view to supplementing labour at ports where the supply of local registered dock workers is inadequate for the purpose of dealing with the additional traffic caused by the diversion of shipping.

The necessary arrangements for transferring men from port to port will normally be in the hands of the local Port Labour Joint Committees in consultation with the Ministry of Labour and National Service and the machinery of the Employment Exchanges is being placed at the disposal of the industry in order to facilitate the transfer of the men. For the purpose of the scheme the Transport and General Workers' Union will prepare a list at the Union's offices in the ports of those men who are willing to volunteer for transfer temporarily from their home ports when their services are required elsewhere. Men will not be transferred from a distance (i.e., from ports not within daily travelling distance) unless there is a reasonable prospect of their being required for at least six days.

The Government are assisting the scheme by providing each man so transferred with free travelling facilities to destination and back, together with an allowance of 6s. 6d. for the days on which the man travels, and by guaranteeing the minimum payment of 10s. a day (taking account of earnings) for a minimum period of six days. Each man required to remain in the port for longer than six days will continue to be guaranteed a minimum payment of 10s. (taking account of earnings), for each succeeding day until sent home, with the exception of Sundays, when the guarantee will not apply unless the man is required to be in attendance.

The employers on their part undertake to pay to each man transferred under the scheme a subsistence allowance of 5s. a day or the equivalent, while he is at the port to which he has been transferred. In the case of men transferred from ports within daily travelling distance, free travelling facilities will be provided by the Government.

Trade at the Port of Baltimore.

According to advance figures supplied by the U.S. Maritime Commission, the Port of Baltimore handled approximately 12,000,000 tons of cargo in the calendar year 1938. Reflecting the prevailing unsettled domestic and overseas conditions, the port's volume of business last year declined about 20% compared with 1937.

Last year's trade at the port amounted to 11,798,848 cargo tons, with imports totalling 8,957,904 tons and exports 2,840,944 tons. In the foreign trade there were 4.417,971 tons of imports and 1,158,371 tons of exports. Inter-coastal business showed 333,980 tons and 509,509 tons respectively and coastwise traffic amounted to 4,093,865 tons inwards, and 1,019,346 tons outwards.

Imports in 1938 included large bulk tonnages of ores, sugar, molasses, wood pulp, fruits and vegetables, fertilizers, clay and chalk, and sand and cement. Exports mainly consisted of grain, fertilizer materials, coal and coke, heavy machinery, chemicals, and fruits and vegetables. Miscellaneous imports included hides and skins, copra, coffee, teas, spices, rubber, etc.

Notes of the Month

Oil Basin Extension at Rotterdam.

Dredging operations have recently been commenced in connection with a new branch of the Oil Basin at Pernis, Rotterdam, which will have a length of 1,800-ft. and a width of 820-ft. adding some 35 acres to the accommodation in the port for tankers.

Finnish Ports Closed.

A report has been received from Stockholm, that in order to minimise the risk to Finnish ships of being seized, the ports of Helsinki, Hango, Viipuri, Borga and Kotka, in the Gulf of Finland, have been closed to Finnish shipping. The order does not affect foreign vessels.

Cork as Transhipment Port.

Cork Harbour Commissioners have approved a recommendation that the general manager be authorised to negotiate with the revenue commissioners and insurance commissioners for the execution of a Customs bond to cover transhipment of cargoes in the lower harbour.

Suez Canal Traffic.

During 1338 there was a very considerable decline in Suez Canal Shipping caused partly by a reduction in the number of Italian ships and also by a fall in exports from Europe to China and Japan. The net tonnage in transit for 1938 was 34,418,187 while for 1937 it was 36,491,332. Merchandise carried totalled 28,779,000 tons in 1938 and 32,776,000 tons in 1937.

Dredging of Clyde Channel.

Referring to the paragraph headed as above in the Notes of the Month for October, the Clyde Lighthouse Trust have since placed a contract with the Tilbury Contracting and Dredging Company for the removal by dredging of the patches of high ground in question. The work is in hand and is expected to be completed very shortly.

Port of London Extension Scheme Postponed.

In the House of Commons recently the Minister of Transport was asked whether, in view of the international situation it was now intended to discontinue the extension scheme of the Port of London, and in a written reply the Minister stated that the Port of London Authority informed him that, with the exception of the construction of the warehouses at the Victoria Dock, now in hand, they do not at present propose to proceed further with their scheme.

New Harbour at Port of Spain.

The new deep harbour at Port of Spain, recently completed, has been taken over by the Government from the contractors. The quay, which can accommodate six or seven large ships, was used for shipping sugar last season and in May a British liner came alongside and embarked passengers. The work, which began in 1935, has involved the reclamation of about 160 acres of land and gave employment to an average of 800 men a day. There are five transit sheds with rail connections.

Port Improvements at Antofagasta.

As a result of an improvement in the accommodation at the Port of Antofagasta, Chile, the steamer "Alkmaar" (6,982 tons gross), owned by the N.V. Koninklijke Nederlandsche Stoomboot Matts., Amsterdam, was recently able to moor alongside No. 4 Mole and load of cargo of nitrate and copper direct from waggons by means of cranes. The cargo consisted of 1,000 tons of nitrate and 400 tons of copper; shipment was carried out at the rate of about 250 tons per eight-hour shift. The extra cost of mooring the vessel alongside was compensated by a saving in lighterage charges. The Port Works Administration hopes to induce the Government to finance continuation and completion of the works.

Additional Slipways at Capetown.

The ship repairing accommodation at Capetown for whalers and small craft will be increased from two to four vessels under the Administration's plan to expand the existing slipway to relieve the present congestion. Two side-slips, each able to take a whaler or trawler, are to be provided alongside the present patent slipway. The work is already in hand and will be completed in good time for the return of the whalers from the Antarctic next March. When it is completed the port will be able to dry-dock or slip simultaneously one vessel of not more than about 400 tons displacement, one of 450 tons, one of 650 tons, and one of 750 tons. In addition, of course, there will be the graving dock, which can accommodate five whale-catchers or small craft simultaneously, so that it will be possible to have no fewer than nine whalers out of the water at the same time.

Germanising Poland.

The German Government has renamed the Polish port, Gdynia, "Gottenhafen."

Tyne River Dues Increased.

At a recent meeting of the Tyne Improvement Commission, it was decided, on the recommendation of the Finance Committee, to increase the river dues by 20%.

Reopening of Dublin Dockyard Postponed.

The Minister for Industry and Commerce has informed the Dublin Trades Council that owing to the European war, negotiations for the reopening of the Dublin Dockyard have been adjourned indefinitely.

Alterations at Arica.

The southern mole at the Port of Arica, Chili, has been demolished and only one mole is now available for the discharge of cargo. A small passenger mole has been constructed between the two original cargo moles, and a stone breakwater, about 100 yards in length, is being built in the place of the southern mole. From the end of this a new mole will eventually be constructed.

Increased Traffic Through Welland Ship Canal.

According to figures recently published in Ottawa, traffic passing through the Welland Ship Canal during July last, amounted to 1,700,000 tons, an increase of 8% compared with the corresponding month last year. Shipments of wheat totalled 8,572,000 bushels, petroleum and oil 21,000 tons and bituminous coal 182,000 tons.

Swedish Buoys to Mark Territorial Waters.

A proposal has been submitted to the Swedish Board of Trade that the limits of Swedish and Norwegian territorial waters between North Koster and Stavanger should be clearly marked by means of buoys. It is suggested that the plan would enable ships to travel with greater safety from the Baltic to Stavanger, where, if they wished, they could join the British convoys. The estimated cost of the scheme would be 750,000 kroner (about £42,000).

Closing of Certain Canadian Ports.

On account of the war, the Government of Canada have under consideration the necessity in certain eventualities of closing some of the entrances to ports in the Dominion, and a notice has been issued to mariners warning them of this possibility and urging them to keep a sharp look-out for signals, details of which are set forth in the notice. If these signals are displayed vessels must approach the port with the greatest caution and implicity, obey all orders or signals given them by the Examination Vessel or Signal Station.

Tasmanian Harbour Improvements.

At a recent meeting of the Burnie Marine Board, Tasmania, a letter was received from the Treasury giving formal approval to the borrowing of £30,000 at 4% by the Board for harbour improvement. The harbour master (Capt. E. Evans) reported that during the year ended June 30th, 577 vessels (including 37 oversea ships), with a gross tonnage of 1,556,261 tons visited the port, compared with 610 vessels (1,679,079 gross tons) in the corresponding period of the previous year. Receipts for the year totalled £32,912, compared with £35,238 in 1937-8.

Improvements at the Port of Dublin.

Work on the improvement and development of the facilities at the Port of Dublin has made considerable progress during the past quarter. Two caissons of the new deep-water berth at Alexandra wharf, near the transatlantic shed have been sunk and other projects, involving the expenditure of many thousands of pounds are in hand. In addition to the new wharf running east and west, for which the caissons were sunk, another spur wharf running in a south-easterly direction towards the Alexandra buoy is to be built.

Increased Efficiency at the Port of Rotterdam.

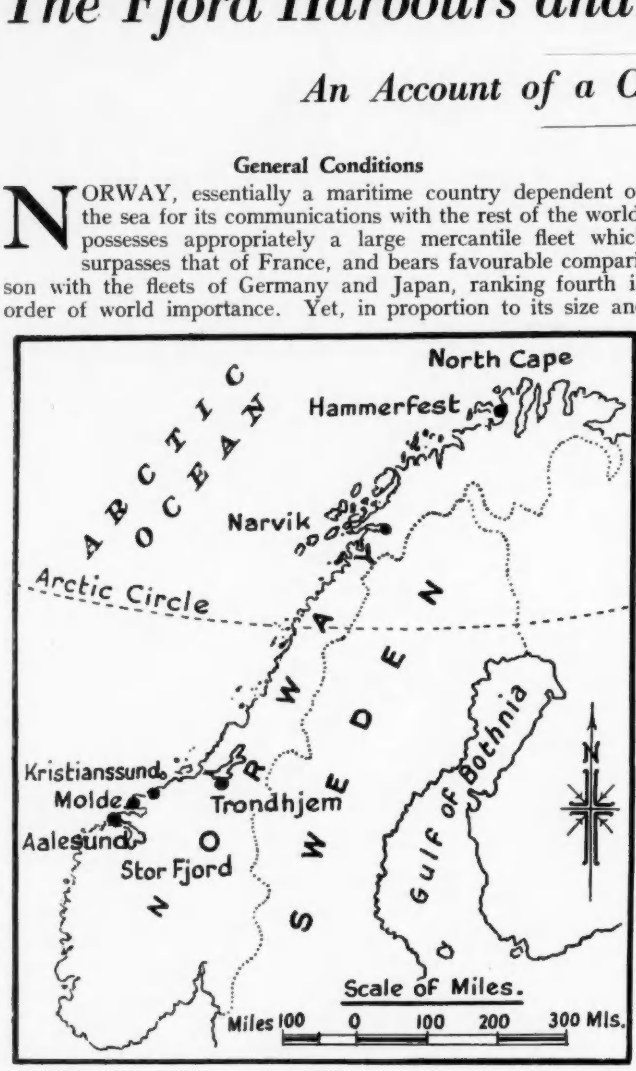
In a report on Rotterdam port labour, a special committee of the Netherlands Government Labour Board has arrived at the conclusion that between 1925 and 1936 the efficiency, measured in tonnage of cargo handled per hour, increased by 71%. The improvement is attributed to the general introduction of labour-saving devices, improvements in equipment, including the introduction of level luffing cranes, of which 144 were in operation at Rotterdam at the end of 1936, better organisation and working methods, greater care in picking men for particular duties, and improvements in the cargo handling equipment on ships.

The Fjord Harbours and Ports of Northern Norway

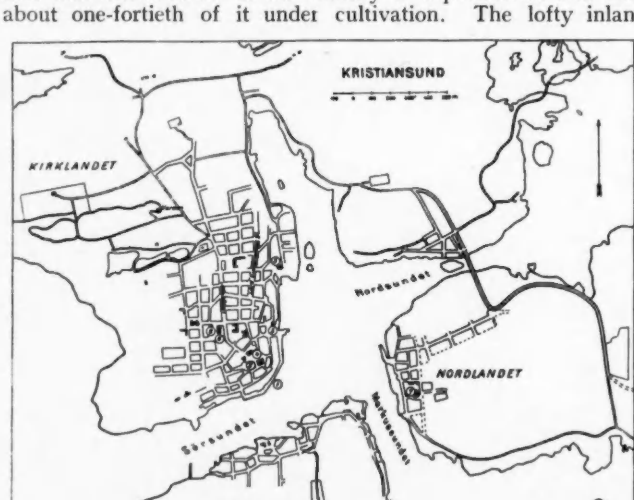
An Account of a Cruise in Arctic Waters

General Conditions

NORWAY, essentially a maritime country dependent on the sea for its communications with the rest of the world, possesses appropriately a large mercantile fleet which surpasses that of France, and bears favourable comparison with the fleets of Germany and Japan, ranking fourth in order of world importance. Yet, in proportion to its size and

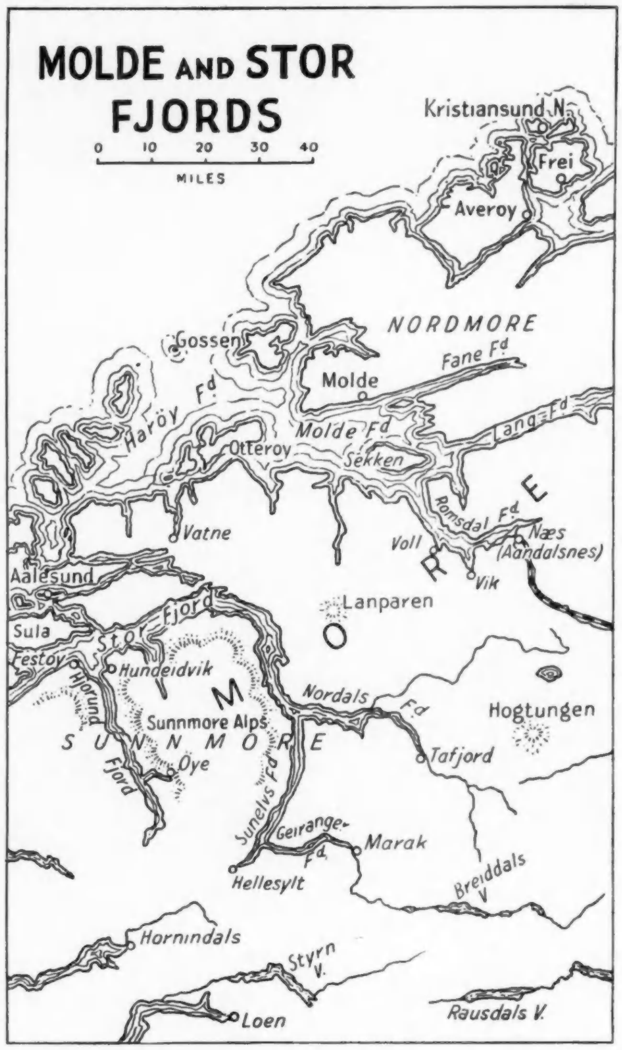


seaboard, the country is but sparsely populated. It has an area of about 125,000 square miles, rather greater than that of the British Isles, but its population does not exceed three millions—scarcely more than the number of inhabitants in Paris, and certainly less than those in Chicago. This is due to the fact that three-fourths of the country is unproductive and only about one-fortieth of it under cultivation. The lofty inland

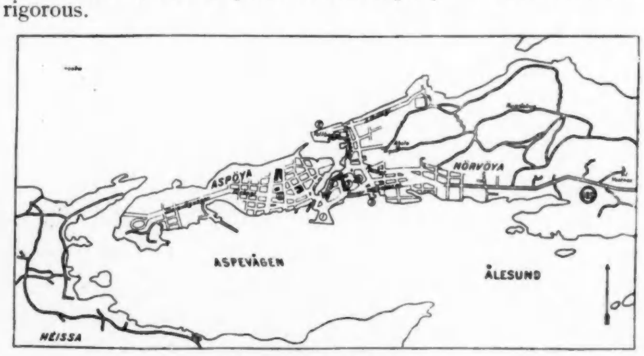


plateau, with its inclement climate, is mainly bog and moorland, and during the long winter season, a vast snowfield. Accordingly, the natives have had to look to the sea for a livelihood and sustenance, and find therein an outlet for their adventurous activities. The hardy race of Norsemen have fished and built ships and sailed the seas for generations past.

The country, and particularly the coast line, is well adapted by nature for water-borne traffic. The western margin is deeply dissected by long, winding inlets, called fjords, which penetrate far inland and provide not only convenient lines of communication, but afford safe and commodious harbourage for craft. Moreover, the coast is fringed with a long line of islands, protecting the inner waters from the onset of violent tempests and



enabling coastal navigation to be carried on under favourable conditions. Owing to the influence of the Gulf Stream and the prevalence of mild breezes from the west, the harbours are not impeded by ice, and remain open all the year round, though in the interior, the temperature falls rapidly and the winters are rigorous.



Harbour of Aalesund.

Trade and Industries

The export trade of Norway, which is of the order of 700 to 800 million kroner* annually, is largely centred in its vast forests of timber. These forests, chiefly of pine and other conifers, cover some 26,000 square miles, and are an important source of wealth. They provide almost unlimited supplies of logs, a large proportion of which is converted into paper pulp

* A Kroner is worth about a shilling in English currency.

Fjord Harbours and Ports of Northern Norway—continued

and paper. The production of this material is aided, as in Canada, by the abundant opportunities for obtaining cheap water-power from the numerous mountain streams and waterfalls. The reserve of water-power in the country is estimated at 9,200,000 kilowatts, of which less than 20% has as yet been utilised.

Fisheries, and their attendant industries, are another valuable source of revenue. Cod, herring and bristling constitute the main harvest of the neighbouring seas, while salmon is taken in inshore waters. The manufacture of cod liver oil affords employment for several thousand men, apart from those engaged in sorting, packing, salting and despatching the catches of fish. In a normal year, the catches of Norwegian vessels exceed those of British fishing fleets.

A third source of wealth is minerals, though these are not so rich as in adjacent countries. There are, however, considerable deposit of iron ore of a somewhat low-grade. Copper, pyrites and chromium are also found.

Hammerfest Harbour.

Aandalsnaes in Romsdal Fjord.

Harbourage in Fjords

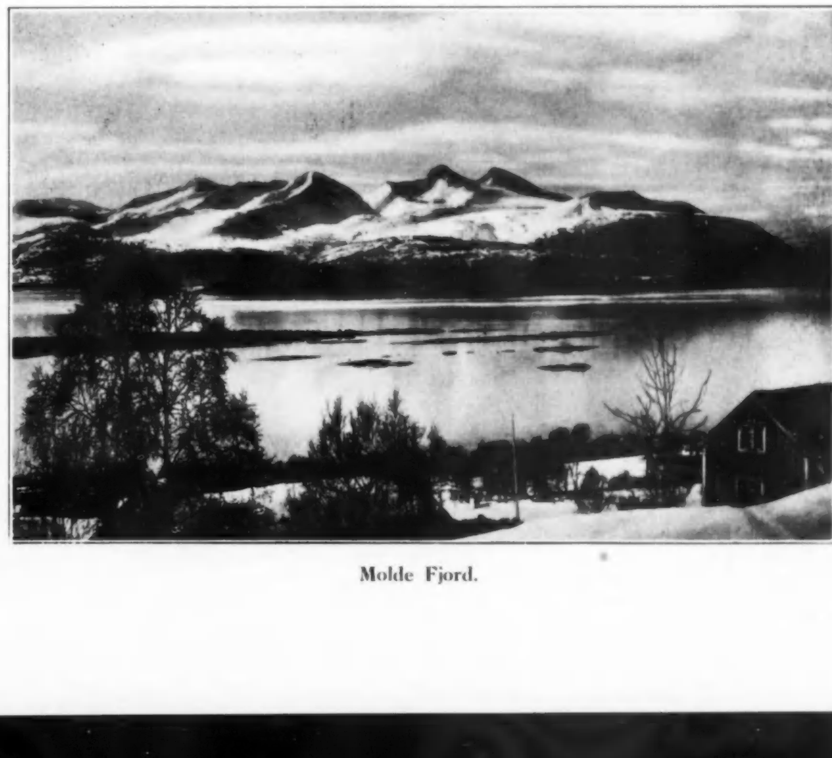
From the point of view of the maritime engineer, the chief interest of a country lies in the suitability of its coastline for the provision of efficient harbourage, and in this respect Norway is abundantly endowed with the requisite characteristics. Along the two thousand or more miles of sea frontage are indentations so numerous and so extensive that their perimeter, including those of the larger islands, is calculated to run to over 12,000 miles. But the strictly utilitarian view of this feature, despite its importance, must be subordinated to another and more attractive aspect, which revealed itself to the writer during a summer cruise of some 800 miles southward from the North Cape.

The predominant impression made by the Norwegian Fjords is a realisation of their entrancing natural beauty, which evokes a wonder and delight similar to that enjoyed in Switzerland, though slightly less in degree, since the mountains in Norway scarcely attain the towering heights of the Swiss Alps. They rise steeply from the water's edge, with surfaces of grey, weather-beaten rock, curiously patterned by the contortions and convolutions of the volcanically disrupted strata, interspersed with plateaus covered with green vegetation and clustering forests of pine, making a picture to rejoice the heart of the appreciative traveller, who finds fresh panoramas of scenic beauty at every twist and turn of the narrow waterways. Here and there in the hollows along the crowded peaks are to be seen charming little stretches of cultivated land, sprinkled with dwelling-houses in variegated colours, or a tiny hamlet nestling at the edge of the fiord, with, perhaps, a modest pier, or a little quay to serve for the purpose of transport of passengers and produce.

And jointly with this impressive spectacular display, the fjords possess a strong technical interest appealing to the harbour engineer by reason of their relatively narrow, deep channels, penetrating far into the interior of the country and providing anchorage, at once sheltered and ample. They are ideal situations for the reception and accommodation of shipping, if only there were the inducement of trade to promote the activities of water transport. Unfortunately, the wild and barren nature of the hinterland and its high altitude preclude the possibility of any important developments of internal trade and manufacture.

Northern Ports

Starting from the North Cape, a precipitous headland rising over 1,000-ft. above sea level, with a winding stoney track to the summit, scaled not without considerable exertion and some amount of risk of losing foothold on the frozen snow of the upper slopes (from the top, when conditions are favourable, an excellent view may be obtained of the "midnight sun"), and proceeding south, the first port of call is Hammerfest, the most northerly port and town of Europe. It lies in latitude 700° 40′ north, the same as the extreme north of Alaska, and has a population of some 4,000. Standing in the little main street of the town on a bright warm morning in early July, it was difficult to believe that the place is well within the Arctic Circle. The climate is relatively moderate and, even in January, the temperature does not fall much below zero. From May 13th to July 29th, the sun is continuously above the horizon. The port possesses a capacious harbour, with anchorage in from 15 to 25



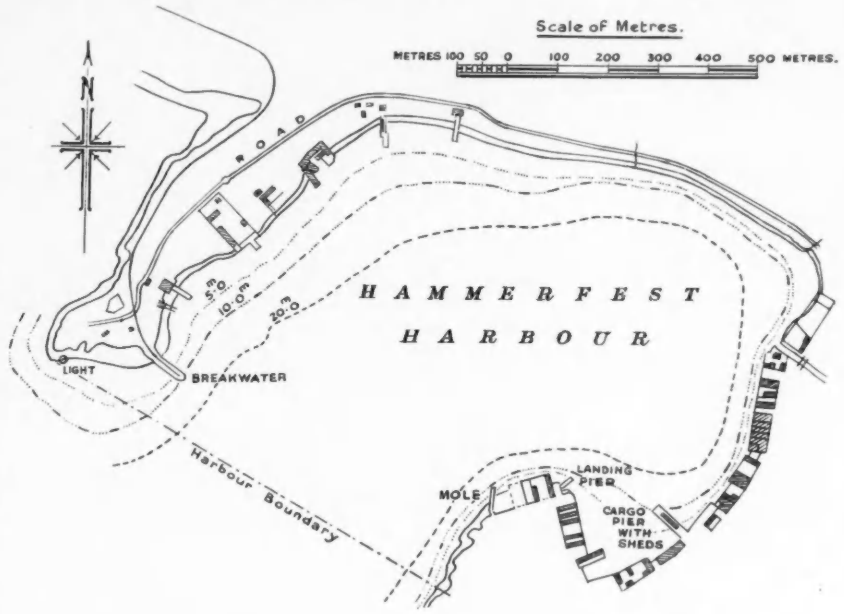
Molde Fjord.

Fjord Harbours and Ports of Northern Norway—continued

fathoms close to the town, and there is berthage for shipping at a quay and a jetty where the depth of water is 25-ft. to 30-ft. The entrance to the harbour is protected by a short rubble stone breakwater, which, however, does not afford complete protection from westerly gales. Navigation is open all the year round. Industry is largely in clothing made in local factories. Salt, coal and grain are the chief imports, and fish, cod-liver oil and whale oil the leading exports.

Tromsö, a rather larger town, with a population of over 11,000, lies less than a hundred miles to the south of Hammerfest, and engages in much the same class of trade. The port lies on an islet between a large island (Kvalo) and the mainland. There is a very productive herring fishery.

Yet another very northerly town and port is Narvik, with considerable traffic in iron ore, brought from mines in Swedish territory. It lies in a sheltered position in the Ofoten fjord, west of the Lofoten Islands. The Iron Ore Company, after 36 years of operation, despatched from the port last year no less than 1,032 vessels, carrying 7,600,000 tons of ore. As regards tonnage of materials handled, Narvik is probably the premier port of Norway, though the quantity of general cargo is relatively small. The entrance to the harbour is half a mile in width, and has a depth of 16 fathoms. There are extensive quays with 28-ft. of water alongside at all tides. The population is about 10,000, and in addition to iron ore, there is trade in coal, coke, salt and cement.



Leaving the Lofoten Islands and skirting the coast for about 400 miles, the next important port is Trondhjem or Drontheim, quite a large town, with a population of 55,000, formerly the ancient capital of Norway, its earlier designation being Nidaros. It is situated on a peninsula in the Trondhjem fjord, and has regular communication with all Norwegian coast towns, as also with English ports, chiefly Newcastle and Hull. There is export trade in timber, wood pulp, fish and minerals. The local industries include shipbuilding and fish curing. Quayage is ample, with shed accommodation, having berthage depths of 26-ft. alongside. Railway connections extend into Sweden. The port possesses two graving docks, both under 300-ft. in length, and a floating dock with a lifting capacity of 4,200 tons. The cargo-handling equipment of the port includes several electric cranes of capacity up to 30 tons lifting power.

Geiranger Fjord. Note large steamer in Fjord.

To the westward of Trondhjem lies the smaller port of Christiansund or Kristiansund, built on four small islands, by which the harbour is enclosed. There is ample quayage accommodation with depths alongside varying from 11-ft. to 40-ft. The chief exports are timber, cod, herrings and fish products. Butter is sent to Great Britain. Cranes are available for lifts up to 10 tons.

Proceeding southwards, the province of Romsdal is reached, with the magnificent Stor Fjord, which although not quite so remarkable as the Sogne Fjord further south, is nevertheless a very striking feature of the coastline. The Stor Fjord sets inland near the Port of Aalesund and, with its branches, is over 70 miles in length. Its scenery is wild and impressive throughout. The Geiranger Fjord, illustrated in this article, is an excellent example.

Aalesund (population about 20,000) stands on three islands, which enclose a safe and commodious harbour, and the port is well known for its export trade in fish and fish products. There are numerous factories in the town connected with the fishing industry, including oil refineries, together with engineering works, etc. It is a recognised port of call for the Norwegian-South American Line, and also for the services between Trondhjem and Germany, France and England. The depth of water inside the harbour is about 24-ft. at low water, and the tide rises 6-ft. There are three older quays north, west and south, with depths alongside ranging from 12-ft. to 29-ft., and a new quay with depths of over 30-ft. Three patent slips are available for docking craft up to 700 tons deadweight, and there is also a floating dock capable of lifting 600 tons.

Before entering the Stor Fjord, a call was made at the little Port of Molde on the North side of Molde Fjord, which leads into Romsdal Fjord, in which lies the charming hamlet of Aandalsnaes, with its delightful background of mountain scenery. Passing thence into the Stor Fjord and Geiranger Fjord, further impressive panoramas were visible, and landings were made at Oie, Hellesyllt and Merok. This concluded the itinerary in Norwegian waters, and the vessel returned to its home port in England after an interesting and instructive tour, affording a serviceable insight into the coastal conditions and industrial features of the northern provinces of Norway.

B. C.

Port of Southampton Health Authority

The annual report for the year 1938 of Dr. H. C. Maurice Williams, Port Medical Officer of Health at Southampton, states that 2,693 steamers, motor ships, sailing vessels, fishing vessels and flying boats entered the port from foreign countries, and of this number, 1,181 were inspected by the medical officer of health and 2,188 by the health inspector. The number of these vessels reported to be defective was 96, and the number of vessels in which defects were remedied was 86. Vessels entering the port on coastwise voyages numbered 13,187; nine of these were inspected by the medical officer of health and 1,089 by the health inspector. The number reported to be defective was 136, and the defects were remedied in 88 vessels. The systematic measures which are carried out each year for the destruction of rats resulted in only 1,420 rats being caught (340 in vessels and 1,080 on shore). Schedules of work to correct or protect rat harbourage and runs were served and complied with in the case of 37 vessels requiring Deratisation Exemption Certificates.

*Dock Gates**

By F. M. EASTON, A.M.Inst.N.A., A.M.I.Struct.E.

AT ports subject to tidal fluctuations the water is usually impounded at a level approaching that of high water of spring tides and often at a considerably higher level. The entrance locks are generally provided with two or three pairs of double leaf gates, rotating on vertical axes at the sides of the lock. This paper deals with the design and construction of such gates according to modern British practice, for waterways between 50-ft. and 130-ft. in width and in depth from 25-ft. to 55-ft.

The paper is in some respects supplementary to one on "The Design and Construction of Modern Dock Gates," by Mr. T. L. Norfolk, Engineer-in-Chief to the Mersey Docks and Harbour Board, given in 1916 before the Liverpool Engineering Society. It has been necessary to go over, in part, the ground covered by Mr. Norfolk, and for permission to do this, the present writer acknowledges his indebtedness. The opinions here expressed are, of course, the author's own.

Not only have lock gates to be capable of withstanding the head of water which bears upon their backs after they are closed, or "mitred," but they and their anchorages have to resist racking and distortion under the severe stresses which may come upon them while in service. Racking forces are brought into play when the line of application of the pull or thrust for moving a gate does not coincide in position with the resultant of the resisting forces, namely, the inertia of the structure, water resistances and friction at the rollers supporting the outer end of the gate, if any are fitted. Racking forces capable of causing considerable damage may arise should a gate get out of control under wave action in stormy weather or when closing while there is a "run" of water out of the lock, for in such an event the gate may be carried with considerable force against the masonry sill at the bottom of the lock. Again, racking and damage may ensue if a gate or its supporting roller meets a submerged obstacle on the gate platform or nips an obstruction when closing against the sill. Gates are also liable to damage by the impact of vessels entering the lock and, in exposed positions, they have to resist the buffeting of heavy seas.

In addition, the metallic parts of lock gates are, for the most part, exposed to the effects of sea-water corrosion under tidal conditions, being alternately submerged and exposed to a marine atmosphere and the action of salt-water spray.

Once gates have been put into commission many parts of the structure are very difficult of access or entirely inaccessible for repairs and painting. Repair work of any great extent cannot be carried out at all upon the gate *in situ* or, at best, can only be undertaken at great expense and interference with the normal working of the lock. To take a gate out for general overhaul and repair is also an expensive operation, and may entail serious inconvenience and dislocation of shipping traffic, as the lock may have to be closed to shipping for many weeks.

For these reasons, gates have usually to remain in commission for at least ten years before being taken out for overhaul. There are many cases of gates working continuously for 15 or 20 years, or even longer.

In order that lock gates shall be able to work efficiently and give lasting service under such onerous conditions, it is of the utmost importance that the greatest possible care should be taken not only with the general design, giving full attention to conditions at the site, but with the design of every detail. Experience has proved, further, that in the long run it is economical to insist that a high grade of materials of their respective kinds and the best possible workmanship shall be used in construction.

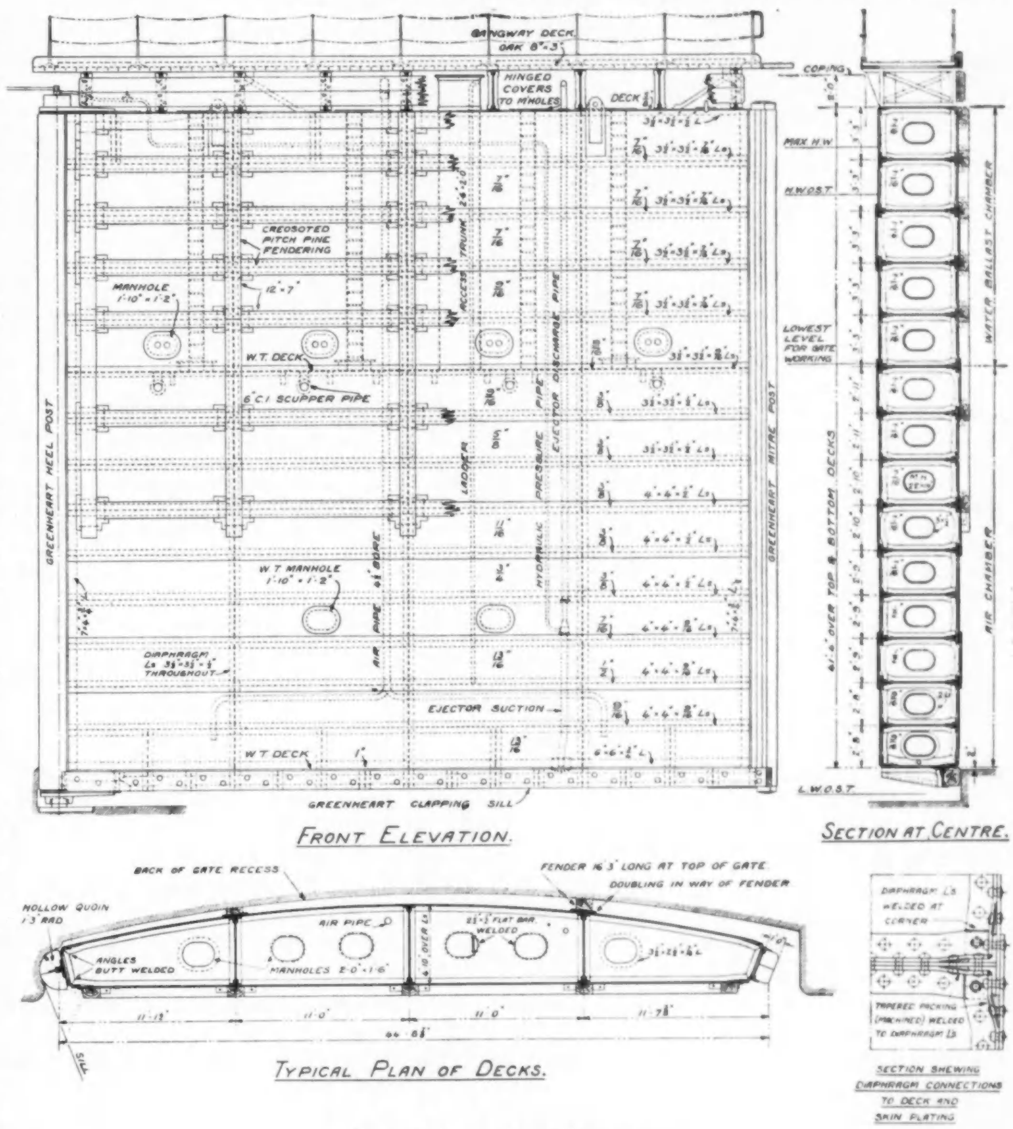


Figure 1 Gates for 80-ft. entrance.

Modern dock gates are constructed of mild steel plates and rolled sections; wrought iron has not been used for this purpose since 1914. Timber heel posts and mitre posts are fitted at the inner and outer vertical ends respectively, and timber clapping sills are fitted along the lower edges of the gates; these timbers are dressed to be an exact fit, when closed, against the masonry of the hollow quoins and pointing sills, and against one another at the mitre ends, thereby providing an effective watertight seal.

The general arrangement of a gate leaf is shown in Figure 1. The structure consists of a number of horizontal decks or ribs with several vertical bulkheads or "diaphragms" worked intercostally, the whole having watertight plating on back, front and ends. The gate rests and swings on a pivot at the heel end and is fitted with a gudgeon at the top, which works in a bearing strongly anchored back to the lock wall. Two of the decks are made watertight to provide an air chamber at the lower part of the gate, which by its buoyancy supports the greater part of the weight. The upper part of the gate, on front or back, allows the free entry of water through scupper pipes and other openings so that the contained water, acting as ballast, adjusts its level automatically to whatever may be the water level in the lock when the gate is swinging, and so prevents any undue

*Paper read before the Institution of Structural Engineers on 24th November, 1938, and reproduced by kind permission of the Institution.

Dock Gates—continued

fluctuation in the working preponderance of weight over buoyancy. The top deck of the gate usually carries a gangway for pedestrian traffic across the lock.

Gates have sometimes been constructed with straight backs, curved at the ends, or with straight backs and trapezoidal ends, but these designs have no special advantage, and the fully curved back is preferable as it makes construction easier.

Principal Dimensions

Steel gates have been built and have functioned satisfactorily, with a rise of sill varying from $\frac{1}{4}$ to 1/6.8 of the span between centres of hollow quoins, but most sills have a rise of one-fifth to one-sixth of the span.

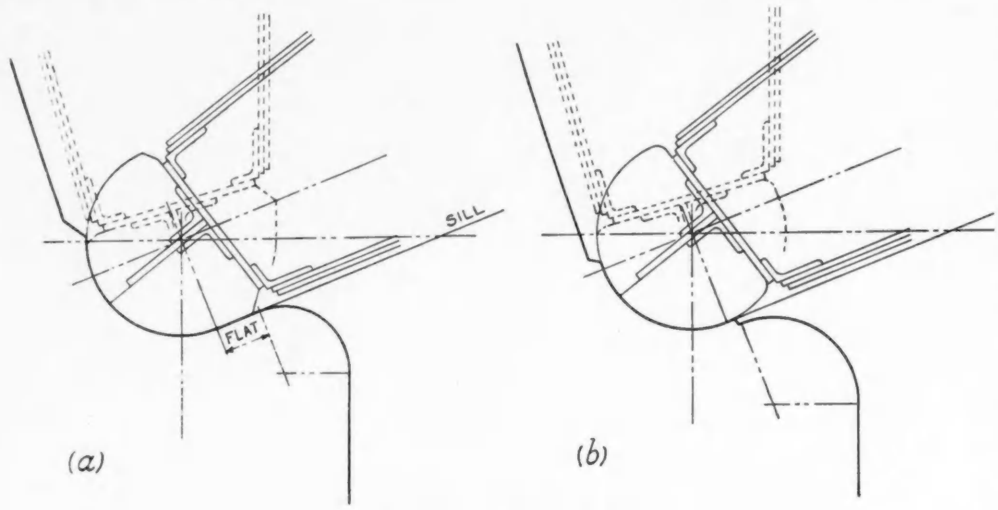


Figure 2 Hollow Quoins.

The moulded breadth of the gate leaf, that is, the maximum width, front to back over boundary angles, may be from one-twelfth to one-fifth of the length of the gate, measured between centre of heel post and centre of mitreing face. The lower ratio, one-twelfth to one-tenth, has sometimes to be accepted when designing gates to fit existing shallow recesses, but so slender a gate is liable to excessive deflection or "whippiness" when being opened or closed, especially if the depth, top to bottom, should exceed the length. On the other hand, a width of one-fifth to one-seventh the length is only necessary where sufficient buoyancy of the air chamber cannot otherwise be provided in designing gates which are required to work at an exceptionally low-water level, or where the buoyancy is considerably reduced by the provision of a number of large sluices for levelling purposes.

The top of the air chamber should in no case be above the lowest working level of water in the lock. In the case of inner gates, this level is, of course, nearer the top of the gate, but it is always desirable that the air chamber should be kept well down in the gate, in order to minimise the risk of flooding by collision. Except in the special cases above mentioned, it is found that a width of one-eight to one-ninth the length is consistent with a suitable height of air chamber and, moreover, such a width gives a gate of adequate stiffness to resist the shocks and racking forces to which it may be subjected in service.

The width of the leaf at the ends should be at least sufficient to support the timber heel and mitre posts and allow easy access for riveting the steelwork and bolting the timber work. It is advantageous to allow as generous a width as possible at the ends, for this greatly facilitates the efficient arrangement of the steelwork in these parts and of the top gudgeon and heel socket connections; it also helps in keeping the top of the air chamber well down in the gate. Further, the shearing stresses in the deck plating and riveting, which are at a maximum at the ends, will then be less likely to require any special measures to keep them within safe limits.

Table I shows, for lock gates, recommended dimensions which are based on those of existing gates. Graving dock gates, not being subject to such heavy usage as lock gates, may have rather lighter timbers at heel post, mitre post and clapping sill.

Care must be taken, in fixing the contour of the leaf in plan, to allow adequate clearance between the back skin plating and the masonry of the gate recess at the hollow quoins with the gate fully open; also, with the gate closed, to allow clearance between the front skin plating and the masonry of the bull-nose between the hollow quoin and the face of the lock wall. (Figure 2).

In gates fitted with supporting rollers, it has often been the practice to make the space between the two lowermost decks non-watertight from end to end, presumably for convenience in designing the structure in which the roller carriage is housed. The disadvantage is that the non-watertight space is liable to become filled with mud, and that the top of the air chamber is necessarily higher in the gate. It is preferable that the bottom deck of the air chamber should be the lowermost in the gate, whether rollers are fitted or not.

The height of the gate should be such that the top deck is about 2-ft. above the highest spring tide level, or above the highest level at which water may be impounded in the dock by pumping.

The vertical diaphragms are pitched from 10 to 13-ft. apart; this gives, for 50-ft. entrances, two diaphragms per leaf; for 60-ft. entrances two or three diaphragms; for entrances between 60-ft. and 100-ft., three diaphragms; for entrances between 100-ft. and 120-ft., four diaphragms, and for entrances between 120-ft. and 130-ft., five diaphragms.

Watertight Sub-division

If, as the result of a collision or considerable leakage of water the air chamber of a gate became filled with water, it would be heavy to operate; if the working of the gate in this condition were continued the heelposts might become heavily worn by abrasion in the hollow quoins. The contingency may be guarded against by making watertight some of the bulkheads and decks in the air chamber, thus sub-dividing it into a number of watertight spaces. This involves the provision of additional access trunks, and complicates the arrangements for ventilating and draining the gate, and to a certain extent, obstructs easy access to all parts for the purpose of periodical inspection. Damage by collision is not infrequent, but generally affects only the upper part of the gate, above the level of the air chamber; damage to the plating of the air chamber very rarely occurs. In the author's opinion, therefore, it is not necessary to make watertight sub-divisions in the air chamber, except in those cases where the most serious hindrance to shipping traffic would result from a gate being temporarily taken out of commission for repair. In many cases there are alternative entrances to the dock; in others, there are spare gates available or, in a lock provided with three pairs of gates, two at least of the three pairs, the middle and outer, may be made interchangeable.

To reduce the likelihood of damage by collision, the gates should be protected, both front and back, by the provision of stop chains across the lock.

TABLE I.

Width of Entrance	Radius of Heel Post	Moulded Width of Gate Leaf, corner to corner		Mitre Post		Clapping Sill	
		At Heel End	At Mitre End	Width (max.)	Thickness	Depth	Thickness
Feet	Inches	Inches	Inches	Inches	Inches	Inches	Inches
50	10—11	17—23	17—23	14—16	9	11—14	10—12
60	12—15	22—27	22—27	16—24	10—11	13—15	12—13
70	15—17	27—30	25—30	22—27	10—12	13—15	12—13
80	15—17	27—30	25—30	22—27	10—12	13—15	12—13
90	16—18	28—32	26—32	23—28	11—13	14—16	12—13
100	18—24	32—34	29—34	26—28	11—13	15—16	13—15
130	20—24	32—34	29—34	26—28	12—13	16—18	13—15

Dock Gates—continued

Weight and Buoyancy

The preponderance of weight over buoyancy at the highest recorded water level should be made as small as possible, in order that the gates may not be unduly heavy to operate and to minimise, in rollerless gates, the wear of the heelpost timber in the hollow quoin. The preponderance, however, must be sufficient to keep the gate down on its pivot and to prevent any tendency to rise at the mitre end when swinging. These requirements can usually be met by providing a preponderance of about 5% of the weight of the leaf, or in positions exposed to

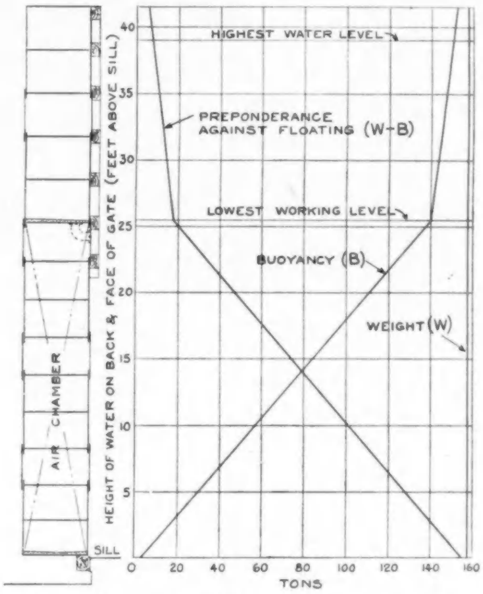


Figure 3 Gate for 80-ft. entrance. Buoyancy diagram, gates open.

wave action, 10%. It is always advisable to calculate not only the weight and buoyancy in this condition, but their moments about the axis of the heelpost, or more correctly, about the centre of the top anchor strap. The moment of weight must have at least 2½% excess over the total lifting moment. Allowance should be made for the thrust of the operating machine, which in some cases has a component acting along the gate exerting a considerable lifting moment about the top anchorage.

As these margins of weight and moment represent small differences between comparatively large quantities, it is necessary for safety that the calculations should be made with the utmost accuracy. Rivet heads will weigh from 2% to 3% of the total weight of structural steelwork. For materials of variable density, such as timber and protective compositions, actual samples should be weighed. The density of the water in which the gates will work should be ascertained; this may vary between 35 and 36 cu. ft. per ton, according to the salinity of the water.

It may be found necessary, as a result of such calculations, to place inside the gate near the mitre end a quantity of kentledge. Permanent ballast, either of cast iron or water, is an obstacle to inspection and maintenance of the structure, and its use can usually be avoided by an adjustment in the capacity of the air chamber, provided the design is fully completed and exact calculations made before construction is begun.

Figure 3 shows a flotation diagram for a gate for an 80-ft. entrance. It is obvious that should the top of the air chamber be placed above the lowest level of water in which the gates usually work, the preponderance of weight at low levels increases to an undesirable extent.

The scupper pipes and any other openings through which water flows into the ballast chamber must be large enough to permit the water level to rise inside the gate at the same rate as it rises in the lock, otherwise the gate may become unduly buoyant and lift off the pivot.

Throughout the water ballast chamber, air escape holes must be provided in each compartment to prevent the formation of air locks in the underside of the decks.

Besides ensuring, as described above, the stability of the gates in the swinging condition, it is necessary to make certain that they will not lift in the quoins when they are closed and supporting a head of water on the back; this applies when the gates are fully plated on the back and have openings or scuppers on the front faces which allow water to flow freely from the ballast chambers as the tidal level falls. The buoyancy due to the hydrostatic pressure on the underside of the gate and clapping sill becomes considerably augmented by the loss of ballast water and by the projection, if any, of the clapping sill timber beyond the face of the gate. The pressure of water on the back of the gates thrusts the heelpost into the hollow quoins and the frictional resistance due to this pressure, added to the dead weight of the gates, must for all levels of water be in excess of the total buoyancy.

In general terms:—

Let H = head of water on back of gate, in feet.
h = head of water on face of gate, in feet.
L = length of gate from centre of heel post to centre of mitreing face, feet.
V = rise of gate to centre of mitreing face, feet.
P = water load supported by gate, in tons.
n = number of cubic feet per ton of water.
T = thrust of gate in hollow quoin, tons.
μ = coefficient of friction between heel post and quoin.
F = frictional resistance to lifting, tons.
W = dead weight of gate, tons.
B = buoyancy of gate, in tons, including layer outside flat face due to projection (if any) of sill timber.
Q = total resistance to lifting, tons.

$$\text{Then } P=\frac{L(H^2-h^2)}{2n},\quad T=\frac{PL}{2V},\quad F=\mu T,$$

$$\text{and } Q=W+F-B=W+\frac{\mu L^2(H^2-h^2)}{4nV}-B.$$

Consideration should be given to all differential heads H and h that are likely to occur and calculations for the corresponding values of Q should be made where necessary. Figure 4 shows in diagram form typical results for a gate for a 100-ft. entrance.

Critical uplift conditions will be found to occur, not when the gates are supporting the maximum head on the back and with no head on the face, but when the water on the face comes level with the top of the air chamber.

The coefficient of friction, μ, may reasonably be expected not to fall below 0.35 for greenheart on granite. It will generally be found that gates open on the front face are safe against uplift at all water levels, even with so low a coefficient of friction as 0.2 or 0.15.

In some instances, particularly for gates at dry-dock entrances, greenheart timber has been used for the hollow quoins as well as for heelposts. The coefficient of friction in this case is about 0.1.

The tendency to lift may be effectively overcome by transferring the scuppers or other openings of the water ballast chamber to the back of the gate, so that water is retained in the ballast chamber as the tide falls away on the face of the gate. The disadvantage, in the case of inner gates of a lock or basin, is that the ballast chamber is constantly full of water, and special arrangements have to be made for inspection and maintenance of the internal structure or in connection with repairs to the flat skin plating.

As an aid in making preliminary estimates of weight and buoyancy, and in determining approximately the requisite

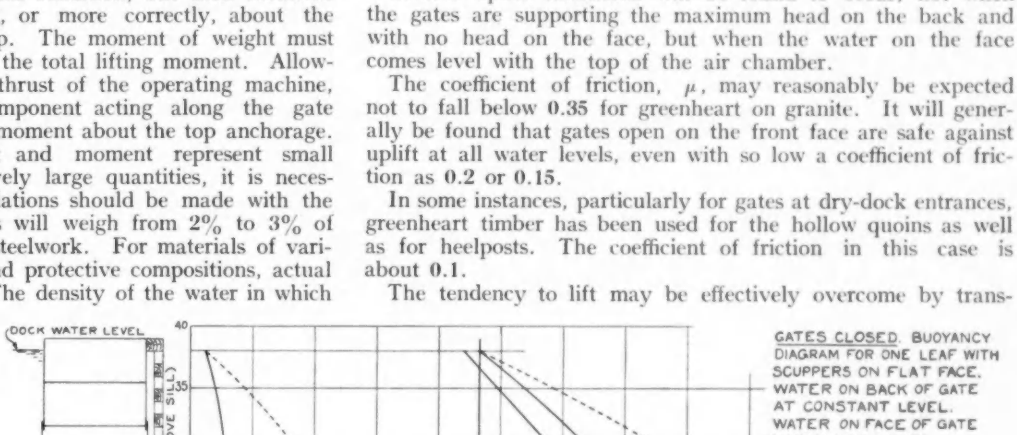


Figure 4 Gate for 100-ft. entrance. Buoyancy diagram, gates closed.

Dock Gates—continued

depth of air chamber, the following empirical formulæ represent average results for existing gates of the type shown in Figure 1.

The swinging weight of one leaf, including top gangway but excluding sluices, roller and associated fittings, gate operating lever and connecting rod may be taken as

$$W = \frac{L(B+D)}{19.6}\left\{1 + \frac{L(B+D)}{3960}\right\} \text{ tons}$$

where L = length in feet from centre of heelpost to centre of mitreing face.

B = moulded breadth over deck angles, feet.

D = depth of leaf over top and bottom deck plates, feet.

each leaf, between decks 4-ft. 4-in. apart. No. 6 has a sill curved in elevation, straight in plan; the bottom compartment, 8-ft. 1-in. deep at mitre end, 1-ft. 9½-in. deep at heel, has its skin plating supported by stiffeners at about 2-ft. 9-in. spacing.

Strength of Skin Plating and Structure Generally

The principal dimensions being settled (subject to adjustment as may be found necessary for strength or flotation in the completed design), the spacing of the decks and thicknesses of skin plating must next be determined.

The skin plating resisting the water pressure and being supported by the decks, diaphragms and stiffening frames (if any)

TABLE II.

Reference No....	1	2	3	4	5	6	7	8
Date built	1914	1928	1930	1933	1934	1938	1938-39	1938-39
	ft. in.	ft. in.	ft. in	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
Width of Entrance	100 0	60 6	49 0	80 0	60 0	80 0	100 0	60 0
Span between centres of hollow quoins	105 4	63 6	52 9½	84 0	64 0	84 0	105 4	64 0
Rise of sill	20 4	16 0	10 1¼	15 5½	13 9	19 7¼	20 4	13 9
Length of gate leaf (L)...	56 10½	36 0	28 6	45 0	34 4	46 9	57 0	34 4
Moulded breadth (B)	8 3	4 3⅛	2 4	4 8½	4 8	8 0	7 3	4 7
Breadth at heel and mitre ends, over corner angles ...	2 8⅝ 1 11¾	1 11 1 11¾	1 4½ 1 4½	2 4½ 2 3¾	2 3⅞ 2 3¼	2 3 2 6	2 8⅝ 2 5	2 2⅞ 2 2¼
Depth over top and bottom decks (D)	49 0	39 9	24 10	41 4	42 4	38 2¾ to 44 6	38 11¾	24 10
Minimum pitch of decks	2 6	2 6	2 6	2 8	2 9	2 9	2 8	2 10
Maximum pitch of decks	3 6	3 4½	3 5	3 3	3 4½	3 1 (4 4 for sluices)	3 3¾	3 5
Radius of heel post	2 0	1 0	0 8	1 3	1 1½	1 3	2 0	1 1½
Width of mitre post	2 3	1 9½	1 2	2 1¼	2 0¾	2 3½	2 2½	1 11¾
Swinging weight of one leaf	Tons 294	Tons 102	Tons 43	Tons 151	Tons 116	Tons 219	Tons 222	Tons 71

This gives results usually within $\pm$ 10% of the actual weight, and there is a probability of about 1 in 2 that it will be accurate within $\pm$ 5%.

The weight of the top gangway, complete with supports and fittings, may be taken as $\frac{LB}{31}$ tons.

The weight of any sluices in the gate, complete with operating machinery, is approximately 0.20 to 0.25 ton per sq. ft. of clear opening of sluiceway.

The swinging weight W, as defined above, may be subdivided as follows:—

	Per cent.
Structural steelwork	81 $\pm$ 3
Fittings, including forgings, castings, bolts and piping	4 $\pm$ 1
Timber	12 $\pm$ 2
Paint and protective compositions	3 $\pm$ ½

The displacement of the leaf per foot depth, in way of the air chamber, varies between $0.80 \times L \times B$ and $0.86 \times L \times B$ in cu. ft., the lower value applying usually to gates for 90-ft. entrances and over.

The displacement per foot depth in way of the ballast chamber, including structure, access trunks and all timber is approximately (L − 8) cu. ft., but may exceed this if the fendering is unusually heavy.

Table II. gives particulars of certain lock gates at the Great Western Railway Company's docks in South Wales. All the gates are of the construction herein described, with curved backs, straight clapping sills in plan, and top gangways. All are rollerless except No. 1. No. 2 has a scouring sluice 5 sq. ft. clear opening in each leaf. No. 6 has four levelling sluices, each 19 sq. ft. clear opening in

is approximately in the condition of a series of rectangular panels, each clamped at the edges and uniformly loaded. The behaviour of such plating has been investigated theoretically and experimentally by Bach, Grashof, Montgomerie, Timoshenko, Inglis and other authorities who have shown that the maximum stress in the plate is a bending stress acting in a direction at right angles to the longer side of the panel, and that the support of the shorter side has practically no influence in reducing this stress when the length of the panel is more than about 1¾ times its breadth. For the purpose of dock-gate design, the results of the investigations mentioned are covered by the equation

$$f = \frac{H}{10{,}000}\left(\frac{s}{t}\right)^2$$

where f = maximum skin stress, tons per sq. inch.

H = head of water in feet above centre of panel, assumed to be sea-water weighing one ton per 35 cubic feet.

s = length of shorter side of panel, in inches.

t = thickness of plating in inches.

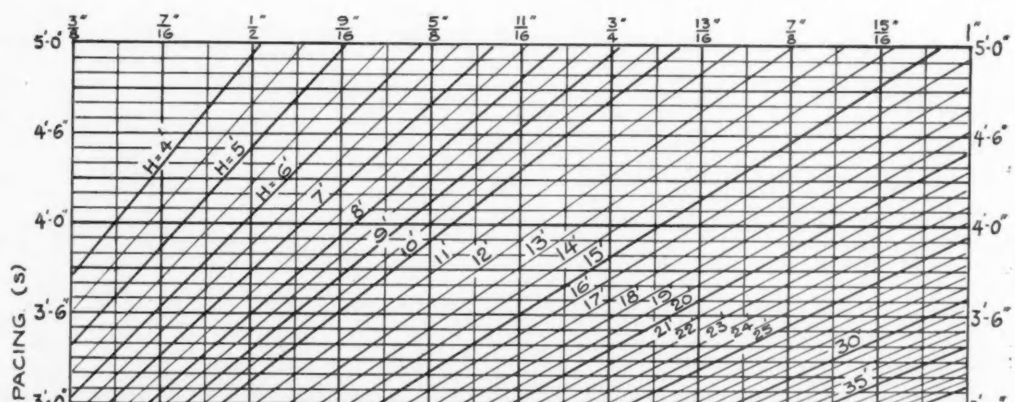


Figure 5 Chart showing thickness of skin plating for varying head of water and span of decks. For sea-water weighing 64 lbs. per cubic ft..

Dock Gates—continued

If the water is of less density than sea-water, the skin stress, f, will be proportionately reduced. The span s, at the ends of which the plating is assumed to be effectively clamped, is measured between centres of decks or other framing, no account being taken of the support of angle flanges, as these are liable to deflection.

A suitable value for the skin stress, f, is 5.6 tons per sq. in. This gives thicknesses consistent with good practice, and allows a sufficient margin for corrosion and for additional stresses imposed on the plating by reason of its function as a girder flange in the structure as a whole. Putting 5.6 for f, the above equation becomes $\frac{t}{s} = \frac{\sqrt{H}}{237}$. This is the basis of the accompanying chart (Figure 5), which gives at a glance the thicknesses of plating for various widths of panel.

The effect of a reduction in the ratio of length of panel to breadth, for a given pressure head, is shown in Table III. The figures are independent of the values of f, H and s. It will be seen that it is only practicable to reduce the thickness of plating, as given by the expression $t = s\sqrt{H}/237$, when the length of a panel is not more than $1\frac{1}{2}$ times its breadth.

TABLE III.

Ratio of length to breadth of panel	2	1.75	1.5	1.25	1
Maximum stress in plating of constant thickness, expressed as percentage of stress in a panel of infinite length	100	98	91	80	62
Permissible thickness of plating for constant value of maximum stress, expressed as percentage of plate thickness in a panel of infinite length	100	99	95	89	78

Using the chart, the spacing of the decks may be arranged in conjunction with the thicknesses of skin plating. There is little or no economy of material in increasing the number of decks in order to permit the use of lighter plating. The minimum pitch should not be less than 2-ft. 6-in. (preferably 2-ft. 8-in.) for easy access and inspection. The maximum pitch should not exceed 3-ft. 6-in., as this will occur at the upper part of the gate where the plating needs support against distortion caused by accidental nipping of floating driftwood in the gate recess, and where the decks should not be very widely spaced, as they are required to give good support to the fendering. Whatever the thickness theoretically necessary, no strake of skin plating should be less than $\frac{7}{16}$-in. thick; a minimum of $\frac{1}{2}$-in. is preferable, so long as the minimum preponderance of weight over buoyancy will not be unduly increased in consequence. This provides a necessary margin of thickness against the heavy wastage and corrosion which affect the upper strakes, in way of wind and water and subject to considerable wear and tear.

The scantlings of the deck and diaphragm plating and boundary angles are tentatively assigned, and the strength of the structure next checked by calculation.

Each deck or horizontal rib carries half the water load on the spans of skin plating immediately above and below it; these loads are conveyed to the masonry of the lock walls and sill by the decks and vertical diaphragms. The varying stiffnesses and elastic deflections of the several members result in a redistribution of the loading on them, which is statically indeterminate and requires advanced methods of analysis for its solution, but it is only necessary to apply such methods to very deep gates, such as the 82-ft. deep gates of the Panama Canal and Welland Ship Canal.

An approximate solution is obtained by assuming that each rib carries the full water load in its vicinity, and that each pair of ribs acts independently as a three-hinged arch with abutments at the hollow quoins and a hinge at the centre of the mitreing faces. The line of thrust, for all practical purposes, will be found to be a circular arc of radius $R = \frac{L^2}{2V}$ passing through centres of hollow quoins and mitreing faces, L and V being as defined earlier. The eccentricity, e, of the thrust at any section of the rib is the intercept between the line of thrust and the neutral axis. The thrust, approximately constant throughout the length of the rib, is given by $T = \frac{P_1 L}{2V} = \frac{P_1 R}{L}$, P_1 being the weight of water borne by a straight horizontal panel of length L and of breadth equal to the mean height of the adjacent rib spaces. The longitudinal compressive stresses on the skin plating, back and front, are then given by $f_1 = \frac{T}{A} \pm \frac{Te}{z}$, A and z being the sectional area and modulus of the girder at the section under consideration.

Where ribs are widely spaced the whole of the skin plating may not act effectively as a girder flange; the width to be included in the calculation for flange area should be limited to 20 times the thickness of the plating, measured outside the centres of rivets in the flange angles on either side of the web, that is, to a maximum of 40 thicknesses plus the distance between the rows of flange rivets. No deductions for rivet holes need be made in the calculations.

The shear stresses in the web plating and skin riveting are examined by the usual methods, applied to a simply supported girder of length L carrying the load P_1.

Stress calculations should be made for a section at the centre of the rib, at one near the narrower end and at an intermediate section. Calculations need only be made for one rib in every four, and the work is facilitated by tabular arrangement.

The longitudinal compressive stress in the skin plating, calculated as above, should not exceed $3\frac{3}{4}$ tons per sq. in., and the shear stress in deck plates and rivets should not exceed three tons per sq. in. If the calculated stresses exceed these values, the sizes of the deck angles, thickness of deck plating and pitch and diameter of rivets should be adjusted as necessary to reduce the stresses to within the values mentioned. There is no need to consider the effect of "nipping" at the mitre posts, whereby the line of thrust deviates from the centre of the mitreing faces, for this does not increase the maximum compressive stress by more than about 10%.

When the heelposts become slightly worn it is impossible for them to bear effectively in the quoins over the lower part of their length on account of the inflexible support given to the bottom decks or ribs by the masonry pointing sill. The ribs in this vicinity then fail to function as arch members, and transmit their load directly to the diaphragms and other vertical members. The diaphragms pass the load through the bottom deck to the pointing sill and, at the upper end, to the ribs there situated, with result that the calculated stresses in the upper ribs are augmented in practice; the increase, however, is covered by the factor of safety.

The strength of the vertical bulkheads or diaphragms may be examined by considering an extreme condition where the heelposts are so worn that the vertical members carry the whole of the water load and transmit it to the top and bottom decks. Each diaphragm, with the associated skin plating, acts then as a girder supported at the ends and carrying a uniformly varying load. As the actual conditions are a good deal less severe, it is safe to design for a tensile or compressive stress not exceeding $7\frac{1}{2}$ tons per sq. in. and a shear stress not exceeding 6 tons per sq. in. It will be found that the calculated tensile and compressive stresses generally fall well within the suggested limit, but that attention needs to be given to the shear stresses in the plating and riveting at the lower end of the diaphragm. In gates for deep entrances, it is advisable to relieve the shear stresses by providing, in the lowermost deck space, one or two intermediate diaphragms between the main diaphragms, as shown in Figure 1.

In service, the diaphragms have to bear heavy, but incalculable racking stresses, due to the gate slamming forcibly against the sill; the lower panels have been known to crack from this cause. Diaphragms should therefore be of rigid construction, well fitted to the decks, deck angles and skin plating, and the manholes should have stiffening angle rings or welded strips (Figure 1) fitted to the webs. The webs should be not less than $\frac{7}{16}$-in. thick in the water ballast chamber, as in this situation they are liable to corrosion and cannot be easily inspected and maintained. In the air chamber the plates may be from $\frac{3}{8}$-in. to $\frac{1}{2}$-in. thick as required by the stress calculations outlined above. The angles should be $3\frac{1}{2}$-in. × $3\frac{1}{2}$-in. × $\frac{7}{16}$-in. or $3\frac{1}{2}$-in. × $3\frac{1}{2}$-in. × $\frac{1}{2}$-in., except near the bottom where wider flanges may be necessary to take the heavier riveting.

(To be continued)

Tyne Improvement Commission.

At the recent triennial election of representatives of shipowners, coal owners and traders on the Tyne Improvement Commission, the following fifteen former members were unopposed and will resume their seats for three years from November 8th: Shipowners' representatives: Mr. R. S. Dalgliesh, Mr. W. A. Souter, Mr. Henry Armstrong, Mr. B. E. Common and Mr. Harry Tully. Coalowners' representatives: Colonel Sir Frank Simpson, Mr. Thomas G. Taylor, Mr. Sidney E. D. Wilson, Mr. William E. Stephenson and Mr. Hugh S. Streatfeild. Traders' representatives: Sir Arthur M. Sutherland, chairman of the Board; Mr. Alfred Raynes, Mr. John A. Greener, Mr. William Waugh and Mr. Basil G. Bryant.

The Evolution of Dredgers

By J. A. S. ROLFE, M.Inst.C.E., A.M.I.Mech.E.

(Concluded from page 349)

Suction Dredger Types

Modern development of the suction dredger has resulted in these dredgers being divided into three classes, the sand pump, the drag suction and the cutter suction. The sand pump has been evolved to deal with sand banks and bars and its mode of operation may best be described as "hole" dredging, as its function consists in removing large quantities of sand whilst remaining at anchor. The sand, being what is known as a "free getting" material, flows freely towards the nozzle being assisted by littoral drift in the case of sand bars in the open sea or by the flow of the current in the case of sand banks in rivers and channels. Here it might be mentioned that Belidor seems to have anticipated this method of "hole" dredging with a dredger illustrated in Fig. 2. Another point worthy of notice in this illustration is that he also made use of "spuds" to steady the dredger.

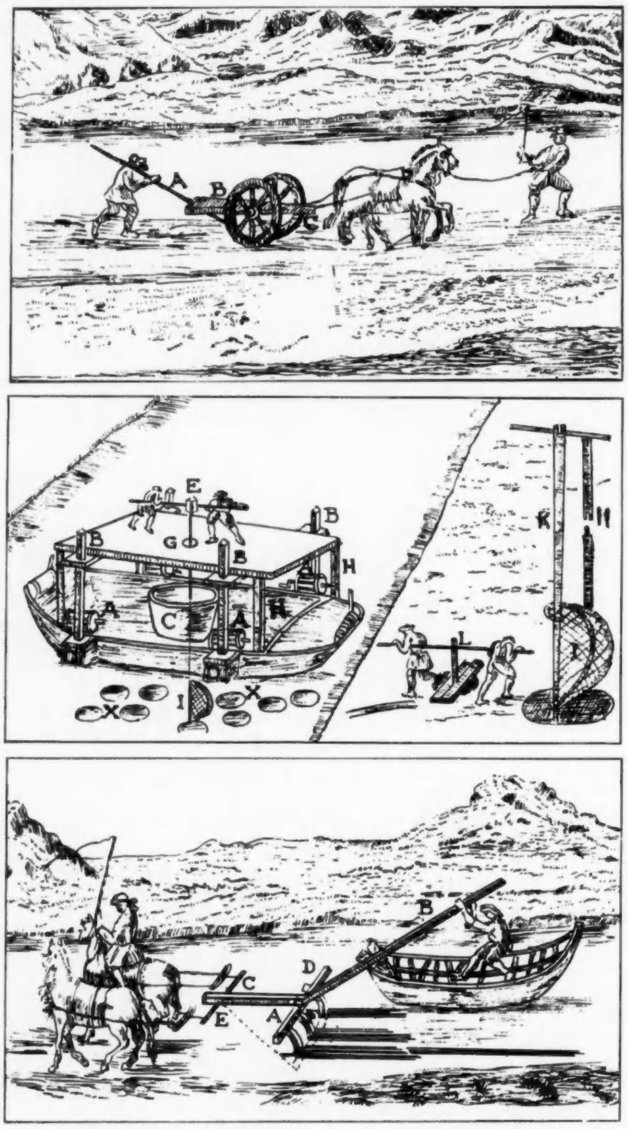


Fig. 2. Methods of Deepening Small Rivers and Canals (Belidor).

The drag suction dredger differs from the sand pump in its method of operation only as it dredges while under way and not at anchor, and its development follows that of the sand pump.

The Cutter Suction Dredger

The first cutter suction dredger appears to have been devised about the same time as the first drag suction dredger. The principal difference between the two is that whereas the drag suction dredger relies on the head being dragged through the spoil to break it up, the cutter suction has a revolving head provided with cutting blades which definitely cuts the spoil. Webster in his paper already referred to describes the "Schmidt" Sand Pump and gives an illustration of the dredger. It was invented by A. W. Von Schmidt and used in Oakland Harbour, California, U.S.A. This dredger had a horizontal disc 6-ft. diameter on which were fastened a number of plough shaped cutters. This wheel, which was driven by a vertical shaft from the deck of the dredger, worked with the cutters downwards inside a hood which was connected to a centrifugal pump on the dredger by a suction pipe 20-in. diameter. When in operation the hood and the horizontal disc was lowered to the harbour bed and the pump and the disc started. The blades on the disc broke up the material inside the hood and the pump raised it to the surface. Unfortunately the date of this invention is not given, although it is described in the Transactions of the Institute of the American Society of Civil Engineers in 1886. A cutter suction dredger which must have been contemporaneous with "Schmidt's" is described in a paper written by Mr. W. J. Barnes, M.Inst.C.E., F.R.G.S., Superintendent of Canal Irrigation, Bahawalpur State, on "Dredgers and Dredging," which was published in 1876 in Volume 5 of the "Professional Papers on Indian Engineering." The Author describes a suction dredger which he and two others, Messrs. Simons and Brown, had invented and patented in 1874. In this dredger the cutting head consisted of a U shaped tube joined to the main suction pipe at the centre of the curved portion and at 90° to it to form a T head, the open ends of the tube pointing downwards. In each of the open ends of the U tube was mounted in a rectangular opening a cutter with eight arms, the arms being set slightly spiral in the length of the cutter. These cutters were driven from the pump by gearing. The arrangement of the driving gear is not described. The suction tube was dragged backwards and forwards across the bed of the canal and the rotary action of the cutters broke down the material of which the canal bed was formed ready for the pump to suck. In each arm of the U tube a valve was placed so that either cutter could be shut off from the pump. It is unfortunate that the date of the invention of the "Schmidt" Sand Pump is not given as it is just possible that Barnes' dredger was invented first. It is not known whether Barnes' dredger was ever constructed. A further point of great interest was the peculiar shape of the hull suggested by Barnes. In place of the ordinary ship shape hull he proposed a hull diamond shape in plan. The idea being that in a narrow channel this type of hull could pivot on one extreme of its beam, which was, of course, the smaller axis, allowing the head of the dredger to make a full sweep of the width of the channel. In modern cutter suction dredging the same effect is obtained by pivoting the dredger about a spud placed in the after end.

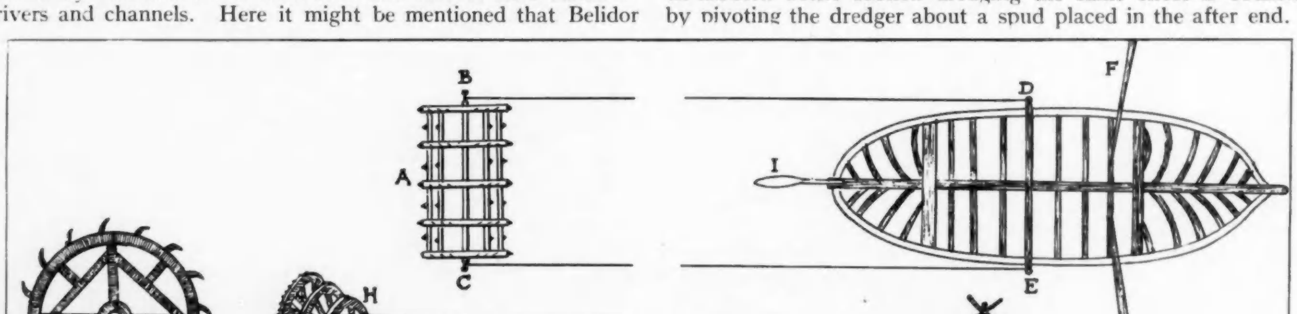
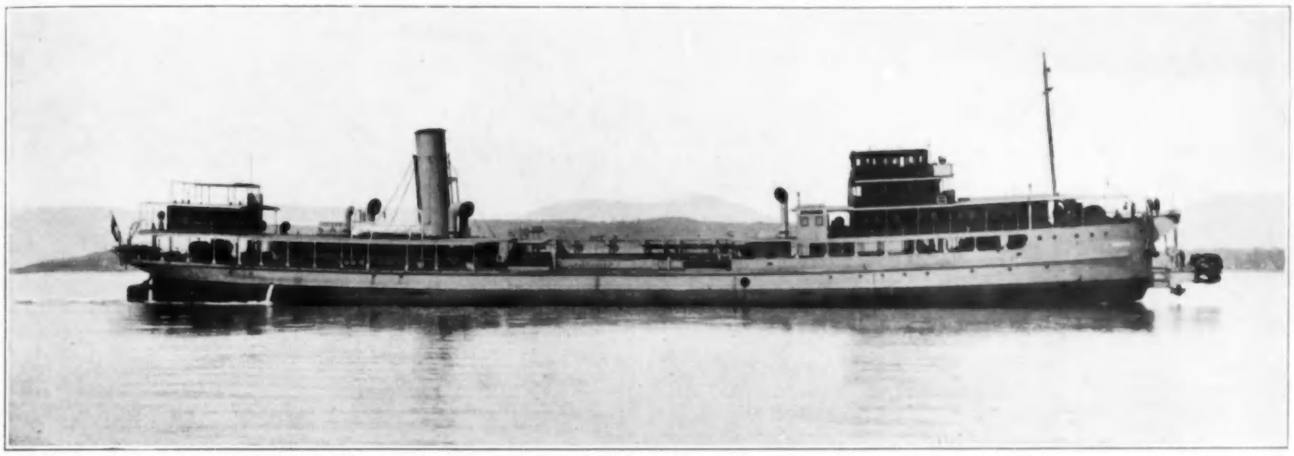


Fig. 3. Method of using the "Hedgehog" wheel for deepening Rivers and Canals

The Evolution of Dredgers—continued

Schmidt's dredger is in principle exactly similar to the cutter suction of to-day, which consists of a rotary cutter, a suction tube and a centrifugal pump. The cutter, which varies in diameter according to the magnitude of the work, consists of six or more renewable steel blades which are arranged in a spiral. This cutter, which is driven from the dredger, in rotating, slices up the spoil ready for passing through the suction pipe.

which served a double purpose in assisting to impel the dredger forward and at the same time stirring up mud which was then carried away by the stream. This dredger was also provided with a scoop, half circular in section, 12-ft. deep and 20-ft. long. The scoop was suspended from davits at the forward end of the dredger, and was operated by lowering it into the mud bank, into which it sank by means of its own weight, and setting



[By Courtesy of Messrs. Wm. Simons & Co., Ltd.].
2,000-ton Drag and Suction Cutter Hopper Dredger "Onger" for the Port of Basrah

the six-bladed propeller in action, this stirred up the mud and drove the scoop deeper into the bank. It was then raised and taken out to deep water and discharged. The scoop carried about 15 tons of mud. He also describes a dredger, the invention of which must have been contemporary with the first cutter suction and with which it has several points in common. The dredger consisted of a vertical telescopic tube slung between two barges reaching down to the bed of the harbour and well stayed to the hull of the barges. At the lower end of the tube was a cutting screw which was driven by a steam engine through a vertical shaft. This screw cut the spoil and at the same time forced it up the vertical tube into a barge waiting alongside. This dredge was used in Chatham Dockyard. Several successful dredgers have been devised in which powerful jets of water have been used to stir up the mud, leaving the tide to carry the mud away.

Dredging is, as has already been stated, a most interesting and fascinating study but, being the dirty side of harbour engineering and the least spectacular, it has been relegated to the background and, in consequence, the records of its development are scanty. It would be perhaps rash to say that no further developments are possible in dredging apparatus, but it can be safely said that while ships come and go dredgers will continue their work in noise and dirt and will still get in everybody's way in busy channels.

Eroding Appliances

It has always been, and still is the aim of dredging engineers, to make Nature do its own cleaning up in harbours or waterways where a strong ebb tide runs, and quite a number of devices have been developed for this purpose. Belidor in his "Architecture Hydraulique" illustrates four machines used for this purpose. The first consists of a cart drawn by two horses with a long pole attached by a pivot to the tail of the cart. This pole was operated by a man who walked behind the cart. From the print it appears that the horse and the cart and the man operating the pole which stirred up the river bed were actually in the river while the attendant who led the horses walked along the river bank. The second machine which has already been partly described in connection with the spuds of the dipper dredger, consisted of a barge mounted on four spuds. In the centre of the barge is a vertical shaft reaching down to the mud and on which is mounted a scoop which acts as a cutter. The vertical shaft was rotated by two men and the action of the scoop was to cut holes in the mud. It is not clear whether the filled scoop was raised on to the deck of the barge and cleared or whether it was raised out of the hole and the run of the stream left to clear the scoop which, by the way, appears to be made of network. In any case, the action of running water over a number of holes drilled in the river bed and the subsequent collapsing of the walls between the holes would have the effect of deepening the river. The third device is similar to the first except that instead of the stirring pole a regular plough with three cutters is employed. This plough is drawn by two horses, on the river bank this time, and is guided by a man in a boat. The fourth machine, called by Belidor a "Hedgehog" consists of five wheels connected together with distance pieces to form an open roller. On the tread of the wheels and on the distance pieces are fixed long spikes. This roller which was mounted on a spindle, the outer ends of which were connected by ropes to a beam laid across a boat, was lowered to the river bed and towed along by means of the barge. The wheels in revolving dug the spikes in and stirred up the river bed, the material thus stirred up being carried away by the stream. As has already been stated, this book was published in 1770, so these inventions are at the very least two hundred years old. The Hedgehog Appliance is shown in Fig. 3, which is a copy of the original plate. Cresy, in his book, illustrates a similar device to the last, also calling it a "hedgehog." He also describes a machine called a "floating clough" which was used to scour the river bed. This appears to have been a heavy timber frame 12-ft. long by 2-ft. wide by 6-ft. deep, with a serrated cutting edge on the down-stream face. The "clough" was sunk to the bottom of the river at half ebb and was allowed to drift along the river bed until full ebb. While drifting, the cutting edges stirred up the mud. This machine was used in the river at Great Grimsby and also in the Humber. On these works, the spoil disturbed is said to have been carried three miles downstream in two hours. Knight describes and also gives an illustration of a dredger used on the Mississippi to maintain a channel through the mud banks. This dredger which was 154-ft. 8-in. long and 23-ft. beam. was provided with a three-bladed propeller 12-ft. diameter by 14-ft. pitch for propelling purposes and one 14-ft. diameter with six blades, forward

Obituary

Shipping and port circles in Glasgow and elsewhere heard with great regret of the death on October 8th, at the comparatively early age of 56, of Mr. William Francis Robertson, Chairman of the Clyde Navigation Trust, of which he had been a member for 21 years and chairman since 1930. In addition to his influential position as a senior partner in the "Gem Line" of coasting vessels (so called because the vessels are named after precious stones), Mr. Robertson enjoyed considerable distinction as a yachtsman, having won a number of trophies with his yacht "Caryl."

It was in 1918 that Mr. Robertson was first elected to the Clyde Trust as a representative of Glasgow Harbour Ratepayers; he was at that time the youngest member of the Trust. His knowledge of trade and shipping proved of considerable service and in 1929 he became deputy chairman, succeeding to the chairmanship in the following year on the death of his predecessor, Mr. James S. Craig. It was during Mr. Robertson's chairmanship that the important river widening and deepening schemes were carried through which enabled the successful launches of the "Queen Mary" and "Queen Elizabeth" to be made.

A number of important extensions and improvements in the dock accommodation of the port were likewise executed, and the cargo handling facilities amplified.

Mr. Robertson was a vice-president of the Dock and Harbour Authorities Association and a member of the Committee of Management of Lloyd's Register of Shipping. He was also chairman of the Clyde Pilotage Authority.

Practical Tidal Prediction

By HERBERT CHATLEY, D.Sc., M.Inst.C.E.

It is well known to harbourmasters that if they can supply continuous tidal observations (not simply high and low waters) it is possible for predictions of tide level to be made which will indicate future tides with a considerable degree of accuracy, provided weather is normal. It is, however, often the case that no automatic tide gauges exist or the authorities begrudge the expense of having the predictions made. It is also often considered, not quite unreasonably, that the accuracy of the predictions, which do not take into account unusual wind or river spate conditions, is insufficient to warrant their preparation. In these circumstances the technical administrator is obliged to do the best he can with the observations at his disposal.

There are many books, such as the well-known manual of Wheeler, or the old " Admiralty Manual of Scientific Enquiry," which provide valuable information as to the observation and behaviour of tides and it is quite feasible to make rough predictions without elaborate methods if sufficient old data are available.

Should such data consist only of high and low water readings, a very useful method is to find by summation and division the average water level. If this is done for every half-moon ($14\frac{3}{4}$ days, say from spring tide to spring tide) and the values be plotted on a time base with each value over the date at which the middle of the half-moon (neap tide) occurred, a good indication will be obtained of the annual rise and fall of the mean level. It is expedient to throw out of the calculation exceptional high and low waters (in pairs) when they are known to have been due to unusually strong wind. If this is done for one year the half-moon averages will still contain some astronomical factors and the process should be carried on for eight, or preferably nineteen, years. This sounds extremely tedious, and indeed is so if tackled in totô at one time, but if the averages are computed from day to day and after each half-moon the work involved is not heavy.

If the results for eight or nineteen years are all plotted on the same annual basis, the generalized curve will be a very nearly correct curve of mean level, showing the regular seasonal effects of barometer change, wind and fresh water run-off or ocean currents. For rough purposes of prediction half the average spring or neap ranges (which may be picked out each half-moon and averaged) added or subtracted from this mean level will give a fair indication of high or low water level at springs or neaps.

Modifying Factors

To get more precise values two other factors must be considered, i.e., the diurnal inequality and the effect of the proximity of the moon.

In some places and at certain times, the diurnal inequality is very marked, two successive high or low waters differing appreciably. This is due to the fact that the sun and moon are not the same height above (or below) the horizon when they are opposite to one another, except at the solstices (March 21st and September 23rd). Speaking broadly, this effect is the same every year and if all the tides are compared with those of eight or nineteen years before the behaviour will be found to be practically the same on almost the same day of the year.

The moon's " apse " is more troublesome and causes a fluctuation of the tidal ranges every seven months or so. The reason for this is simple. The moon has a definitely elliptical path, so that every $27\frac{1}{2}$ days she is nearer than the average and raises a larger tide. As the lunar month (" moon," spring tide to spring tide) is $29\frac{1}{2}$ days there is a shift of the time of closest approach by about two days each lunar month and in 14 such months there is a complete cycle. Since however spring tides occur both after full moon and new moon the concurrence of " perigee " (close moon) with spring tide occurs in half the said time, i.e., seven lunar months (about 207 days). After eight years there is a fairly close agreement at the same time of year (within one or two days) and so exceptionally strong tides will recur. The nineteen year period is not so good in this respect as the perigee occurs about three days off the new moon or full moon recurrence.

Other astronomical factors are relatively small and can be neglected for navigation purposes unless the margin of depth is very minute.

To give some idea of the values involved, it may be said that if the mean daily range is 10-ft., the mean spring tidal range (generally on the 2nd or 18th day of the moon) is 14-ft. and the neap tide range (generally on the 10th or 25th day of the moon) is about 6-ft. The effect of perigee (close moon) occurring at the same time as new or full moon is to add about 2-ft. to the range. These figures are only indicative and depend very much on the position of the port and the local topography.

Particular Phenomena.

Diurnal inequality at spring tides is quite marked in Pacific ports in the summer and winter, but is not so noticeable in most European ports. There is however an analogous phenomenon when two tidal waves approach a port by different routes and cause mutual enhancement or suppression. Hence it happens at certain ports that there is marked inequality of successive high waters or there are intermediate crests (four high waters a day) or even one of the two high waters may disappear giving a long period of almost stationary level. Speaking generally these phenomenon will be repeated at the same phase of the moon at about the same time of the year but perigee and wind may make them rather irregular.

The effect of wind on tidal levels is quite marked in estuarial ports. Hurricanes have been known to raise high water by 4-ft. or so and, by checking efflux, the low water levels may be raised by an onshore wind by 7 or 8-ft. A comparison of the deviations of actual water levels from the predicted values with the contemporaneous winds will enable rough predictions to be made as to the effect of winds of given force and direction.

As to the time of high water, each port has its " establishment " or time after the moon souths at which high water occurs. Since new moon souths at noon and full moon souths at midnight, the establishment is practically the clock time of high water on the day of new or full moon. Each day the tides are, on the average, 54 minutes later, but the interval is not constant. If the times are taken for a whole moon, they will be approximately true for any other moon.

One interesting feature of many local tidal curves is a hump on the rise. This is usually only found in estuarial ports and is due to the water having reached a level at which it can spread over a large foreshore so that it does not rise so quickly. A similar peculiarity may appear during the fall, due to the water having left a foreshore so that the removal of a further equal quantity of water causes a more rapid fall.

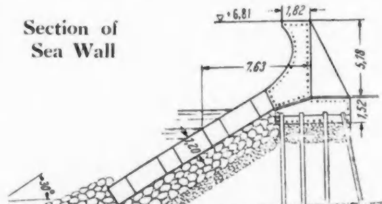
In many harbours, especially in river mouths, currents are as important as tidal levels. They are not so easily or so exactly predictable as levels but continued observation will permit quite useful forecasts to be made. In river harbours slack water does not occur at high or low stage but at intermediate times which should be recorded. If current meter or float readings can be made it is very useful to plot the velocities (floods upwards and ebbs downwards) and compare them on the time base with the tidal levels. In many instances, there is quite a close resemblance between the two curves, so that the predicted tidal levels indirectly provide current predictions.

It is not of course suggested that the above rough methods are so satisfactory as proper analysis but they will often suffice for ordinary navigational purposes. In many harbours the effects of wind, foreshores or irregularly reflected tidal waves from coastal irregularities disturb the purely astronomical tide so much that the judgment of a locally experienced observer provides just as useful a prediction as could be obtained from the most elaborate analysis.

New Sea Wall in Florida, U.S.A.

In a recent issue of " Der Bauingenieur," a description is given by Dr. R. S. Mac Elwee of the new harbour of Canaveral on the Eastern coast of Florida, some 180 miles north of Miami. The site is a narrow strip of land which is separated from the mainland by islets and watercourses, through which, in order to link up the harbour with the network of main thoroughfares of the United States, it has been necessary to construct a connecting roadway, extending for $12\frac{1}{2}$ miles, and traversing reclaimed land and bridges. The port is located in a bay which is naturally protected on the west, the east and the north. It was essential to provide shelter from the South from storms of considerable violence (hurricanes with a velocity of 75 miles per hour are not uncommon). A wave-breaker parapet wall was constructed to the section shown above. There is a foundation mound consisting of a nucleus of quarry refuse of medium size, covered by layers of larger material. The surface course consists of squared granite blocks, each weighing 9 tons, set regularly to a slope of 2 to 1. The foundation depth of the wall averages 40-ft. The parapet has been executed in reinforced concrete with a concave profile facing the sea in such a way as to reflect the breaking waves seaward.

Section of Sea Wall



Port of London Authority

Excerpts from the Thirtieth Annual Report

The following are extracts from the Thirtieth Annual Report of the Port of London Authority for the administrative year ended 31st March last, recently sent to the Minister of Transport:—

Trade of the Port.

The total net register tonnage of vessels that arrived and departed with cargoes and in ballast from and to British Countries and Foreign Countries and Coastwise during the twelve months ended 31st March, 1926-1939, was as follows:—

	Tons.		Tons.
1926 ...	47,505,750	1933 ...	53,860,115
1927 ...	49,995,610	1934 ...	57,470,156
1928 ...	53,141,203	1935 ...	58,895,021
1929 ...	55,404,591	1936 ...	60,597,315
1930 ...	58,451,685	1937 ...	61,796,515
1931 ...	57,526,870	1938 ...	62,949,744
1932 ...	55,678,698	1939 ...	62,085,840

There has been an increase of .1% in the foreign tonnage and a decrease of 4.6% in coastwise tonnage, making a net decrease of 1.4%.

Of the above tonnage, 55.9% used the wet dock premises of the Authority compared with 55.1% during the twelve months preceding.

The shipping entering the dry docks of the Authority during the twelve months was 3,077,170 tons gross, compared with 3,167,553 tons in the previous year.

Finance

The balance of borrowing powers unexercised at 31st March, 1939, amounted to £3,562,042.

The Capital Expenditure for the year ended 31st March, 1939, amounted to £522,673, the principal items being:—

	£
Construction of new quay, North Side, Royal Victoria Dock	262,910
Dredging, etc., South Side, Royal Victoria Dock	19,675
Widening quay, construction of two-storey shed, East Side, Millwall Inner Dock	63,196
Construction of warehouses, South Dock, Surrey Commercial Docks	96,016

The following is a summary of the year's working:—

	£
Total Revenue	5,979,012
Total Expenditure	4,219,981
Balance of Revenue	1,759,031
Less—Interest on Port Stock and Temporary Loans, Sinking Fund Charges, etc., *less* interest, etc., receivable ...	1,729,363
	29,668
Balance brought forward from 31st March, 1938	340,969
Leaving to be carried forward	£370,637

Imports and Exports.

The tonnage of imported and exported goods, foreign and coastwise, of the Port of London, for the twelve months ended 31st March, 1939 and 1938, respectively, was as follows:—

	1939. Tons.	1938. Tons.	Percentage Decrease on 1938
Imports:—			
Foreign ...	16,710,370	18,074,340	— 7.5
Coastwise ...	15,659,565	16,763,016	— 6.6
Transhipments	1,728,380	1,866,804	— 7.4
	34,098,315	36,704,160	— 7.1
Exports:—			
Foreign ...	3,461,287	3,546,211	— 2.4
Coastwise ...	2,374,081	2,526,469	— 6.0
Transhipments	1,728,380	1,866,804	— 7.4
	7,563,748	7,939,484	— 4.7
Total ...	41,662,063	44,643,644	— 6.7

During the twelve months ended 31st March, 1939, the Authority landed or received 2,091,032 tons of import goods for warehousing or for immediate delivery, a decrease of 351,962 tons or 14.4% on the tonnage dealt with during the previous twelve months.

The stocks of goods at the end of March, 1939, in the warehouses directly operated by the Authority amounted to 498,973 tons as compared with 623,504 tons at the corresponding date in 1938, a decrease of 124,531 tons.

The export traffic handled by the Authority on the dock quays during the twelve months amounted to 744,625 tons, being a decrease of 26,921 tons on the previous year's figure of 771,546 tons.

Works and Improvements

Surrey Commercial Docks.—The construction at South Dock of a new warehouse to replace No. 1 Warehouse which was destroyed by fire has been completed and the new four-storey warehouse in place of No. 3 Warehouse is approaching completion. A 25-ton electric Scotch derrick has been erected at Finland Yard, Greenland Dock.

India and Millwall Docks.—At the West India (Export) Dock, "B" Shed is being extended and the work, including the construction of a reinforced concrete false quay in front of the Shed, will shortly be completed. The widening of the quay on the east side of Millwall (Inner) Dock and the construction of a new two-storey shed to replace "M" Shed, together with road and railway connections, are nearing completion. Arrangements are in hand for the reconstruction and deepening of Millwall Entrance Lock and the renewal or reconditioning of the lock gates and machinery; also for the reconstruction of the North Quay (Outer Dock) and the erection there of new warehouses.

Royal Victoria Dock.—On the north side of the dock the demolition of the obsolete jetties has been completed and the new continuous line of quay 3,255-ft. in length has been constructed. A contract has been placed for the erection of five new three-storey warehouses on the reclaimed area behind the new quay and the work is well in hand. On the south side the removal by dredging of land in front of the new quay at the eastern end of the dock is nearly complete and the clearance of the adjacent site to quay level has been commenced. The work of deepening the dock to 31-ft. by dredging is nearing completion.

Royal Albert Dock.—The roadway at the rear of Sheds Nos. 15 to 21 on the north side of the dock is being widened and repaired.

King George V. Dock.—An order has been placed for the supply of eight 3-ton electric quay cranes of 80-ft. radius for No. 5 Berth, necessitating the laying of a special track along the quay.

Tilbury Docks.—Improvements have been carried out at No. 13 Shed for the handling of chilled meat and at Sheds. Nos. 15 and 16 for the accommodation of cargo and for passengers.

Tilbury Landing Stage.—Improved accommodation is being provided at Tilbury Landing Stage to facilitate the Customs examination of passengers' baggage.

River.—An order has been placed for two new diesel-engined launches for the Harbour Service. A considerable length of the river embankment between Kew Gardens and Richmond has been reconstructed and further sections are in progress.

General.—The electrification of quays at various docks has further progressed and an order has been placed for twenty-five additional 3-ton electric quay cranes. Eight cranes previously ordered have been delivered and taken into use. The additional steel pontoons are under construction for use as dummy barges at the Royal group of Docks. The two pairs of lock gate barges are being reconditioned and fitted with steel cradles for use in repairing when necessary the larger lock gates, particularly those at King George V Lock and Tilbury Upper Lock. During the year, 1,544,427 cubic yards of material were removed from the river in order to maintain and deepen the channels. The quantity of mud removed from the docks during the same period was 1,535,081 cubic yards.

General

The amendments prepared by the Authority to their Byelaws relating to the loading, discharging, etc., of petroleum spirit in the Port of London came into operation on the 31st August, 1938. The principal alteration, made at the instance of the Government, relates to the limit beyond which ships laden with petroleum spirit in bulk may not proceed up river and the effect of the amendment is to permit the navigation of such ships up to Crayfordness instead of to the previous limit at Mucking in the vicinity of Thames Haven.

Thirty-two vessels were removed from the river by the wreck-raising plant during the year, viz., 1 motor vessel of 500 tons, 1 steam tug of 182 tons, 24 barges measuring 1,572 tons and 6 small motor and fishing craft. In addition, 4 barges measuring 252 tons were raised in the docks.

The Authority's scheme for Air Raids Precautions has been comprehensively developed with the view of affording protection to personnel and the continuance of the operations of the Port in the event of a national emergency. Volunteers from all grades of the Authority's staff have been trained for the special services required under the scheme and a large expenditure has been incurred for the provision of shelters and equipment and for the protection of the Undertaking.

Port of London Authority—continued

In consultation with the river interests concerned, preparation has been made for certain River Emergency Services including a mobile service for rescue, ambulance and transport work, maintenance of communications, etc. Members of the public have been enrolled for voluntary service and arrangements have been made for the craft required.

Particulars of the Authority's Air Raids Precautions Schemes have been submitted to the Ministry of Transport and the question of financial assistance in respect of certain of the items of expenditure involved is under consideration by the Department.

With the view of co-ordinating their precautionary schemes the Authority appointed Rear-Admiral R. W. Oldham, O.B.E. (R.N. rtd.) to undertake the duties of Air Raids Precautions Officer.

In view of the possible depletion in the ranks of the Authority's Police Force and the extra duties likely to be placed upon the Police in time of national emergency, the Authority decided to proceed with the recruitment of a Police Reserve. The Reserve will be composed of volunteers between the ages of 38 and 55 from the Upper and Lower Division staffs who have not any service obligations with H.M. Forces and they will be liable for service with the Authority's Police Force during war time only.

A Bill was promoted by the London County Council to amend certain of the provisions of the London Building Act of 1930. The effect of the amendments would have been that premises and quayside warehouses and accommodations constructed by the Authority which are at present exempted from the Council's Building Regulations would not continue to be so exempt when used otherwise than exclusively by the Authority. A Petition was deposited against the Bill and evidence given before the House of Lords Select Committee who decided that the Authority's exemptions under the London Building Act of 1930 should be preserved.

The Authority appointed Captain Sir Ion Hamilton Benn, Bart., C.B., D.S.O., T.D., to be a Conservator of the River Thames for the period to the 31st March, 1940, in place of Mr. J. D. Gilbert, D.L., J.P., who has been the Authority's representative on that body since 1925, and had intimated his wish to relinquish the appointment.

Mr. J. D. Ritchie, Acting General Manager, was appointed General Manager as from 30th September, 1938, in succession to Sir David J. Owen, who retired on that date.

The Report is signed by Lord Ritchie of Dundee, Chairman, and Mr. F. S. Blunt, Secretary.

Transfer of Port of London Staff.

The Port of London Authority announce that they have transferred a considerable part of their Head Office Staff to a place in Surrey. The departments concerned include those of the Chief Accountant, Treasurer, Secretary, Solicitor, Establishment Officer, Stores Officer, Estate Office, Chief Draughtsman, Claims Clerk and Charges Clerk (Dock and Traffic Department). A skeleton staff of these and a nucleus of other departments will remain on duty at Trinity Square for the transaction of the usual local business of the port, with Mr. J. D. Ritchie, the General Manager, as Chief Executive.

Latvian Foreign Trade

A review of foreign trade in 1938, published by the Riga Bourse Committee, shows total shipments of timber from Riga to Great Britain were 508,847 cubic metres, and other Latvian exports 165,811 tons. The total seaborne imports from Great Britain to Riga were 412,415 tons. To Germany exports totalled 303,385 cubic metres of timber and 47,433 tons of other goods, while 222,617 tons of German goods were imported.

The aggregate value of imports and exports at Riga last year was nearly 350 million Lats., or well over 85% of Latvia's entire seaborne foreign trade. Over 11% of the trade went by Liepaja and the rest via Ventspils.

Work has commenced on the construction of a new system of waterways for the purpose of floating timber down to the port of Ventspils. The scheme involves an outlay of 200,000 lats., but will save annually 20,000 lats in transport costs.

The leading foreign trade organisations have formed a new company to improve transport facilities for the country's seaborne foreign trade, by means of regular cargo services.

The United Latvian Shipping Co., in order to compensate for the tonnage shortage which the withdrawal of British ships from the Latvian trade has caused, recently decided to organise a liner service on the Riga-London and Riga-Stockholm routes. Efforts are also being made to expand trade with other neutral states in Scandinavia and the Baltic.

Argentine Port Development

The Report on the Economic and Commercial Conditions in the Argentine Republic, June, 1939, by the Commercial Secretary of His Majesty's Embassy at Buenos Aires, just issued by the Department of Overseas Trade (H.M. Stationery Office: Price 3s. 9d. post free), contains a carefully detailed review of the economic position of the country and of developments which have taken place since the issue of the previous Report in April, 1938.

Much of the information is of a general character, and though valuable to British traders and exporters, does not specially concern the purview of this journal. There is to be noted, however, a section on Port Works and Dredging in which port officials will be interested and it is accordingly reproduced as follows:—

Port Works and Dredging.—The estimated expenditure of the Department of Navigation and Ports in 1938 was $22,938,000 pesos paper compared with $14 millions in the previous year. The Department has been authorised to spend $23,016,600 pesos during 1939. In addition, the sums of $3,726,000 in 1938, and $3,860,300 in 1939, were appropriated for the rectification and deepening of the River Riachuelo which enters the River Plate at Buenos Aires. The largest individual items on the Department's programme of development are the construction of the New Port of the Federal Capital (estimated to cost $110,354,503 pesos over a period of years) and the works in course of execution at the ports of Mar del Plata and Quequén (total estimated costs $58,000,000 and $48,847,732 pesos respectively over a period of years). Satisfactory progress was made on all these works during 1938. The programme involving an expenditure of $20 million pesos on dredger equipment, which was authorised at the end of 1936, has been held up; prior to this postponement one dredger was purchased from abroad at a cost of $2,295,000 pesos, while a number of smaller units were constructed locally.

Bulgarian Port Traffic

The following particulars respecting shipping traffic at the ports of Bulgaria are extracted from a report on Bulgarian trade by the Department of Overseas Trade, just issued by H.M. Stationery Office (Price 1s. 6d.). The Report deals with conditions during the period from 1936 to May, 1939, and has been compiled by Mr. T. V. Brenan, Commercial Secretary of Sofia:

Coastal Ports.—In 1937, 2,465 steamers, aggregating 1,854,717 tons net register, and 5,577 sailing vessels, of 58,009 tons net register, or a total of 8,042 vessels of 1,912,726 tons net register, visited the eight ports on the Bulgarian littoral, compared with 6,699 vessels, aggregating 1,811,423 tons net register in 1936. The number of vessels increased to 9,349, of 2,044,790 tons net register, in 1938. The cargo discharged totalled 194,555 tons in 1937 (137,871 tons in 1936), and 229,542 tons in 1938. Against 36,586 in 1936, 35,728 passengers were landed in 1937, and 42,921 in 1938. Outwards, in 1937, there were 8,011 vessels, of 1,919,026 tons, which loaded 368,512 tons of cargo (338,842 tons in 1936) and embarked 45,704 passengers. In 1938, 9,320 vessels, of 2,031,161 tons net register, sailed with 301,250 tons of cargo and 46,596 passengers. According to net registered tonnage, between 80% and 90% of the seaborne and coastal traffic is shared by Varna and Burghaz.

Danube Ports.—The number of vessels of all kinds which arrived at the Bulgarian Danube ports was 13,831 in 1937 and 13,152 in 1938 (14,211 in 1936). Their net register was 2,215,831 tons and 2,197,244 tons, for the two years respectively. They landed 125,970 tons of cargo and 118,934 passengers in 1937 (125,209 tons and 113,026 passengers in 1936) and 142,984 tons and 108,237 passengers in 1938. Thirteen thousand eight hundred and seventy-four vessels, of 2,230,171 tons net sailed in 1937, carrying 246,418 tons of cargo and 110,848 passengers, while in 1938 13,115 vessels of 2,187,834 tons net register left the Danube ports. There was a fall in the quantity of cargo carried to 146,845 tons, but the number of passengers was well sustained at 114,815. The busiest port on the Danube in 1937 was Roustchouk (Rousse), with 38½% of arrivals; next came Lom with 12½%, while Svishtof, Vidin and Somovit each shared to the extent of about 8% to 9% of arrivals.

Alexandria Port Returns.

Official returns of shipping visiting the Port of Alexandria show a decrease in British tonnage in 1938 as compared with 1937, amounting to 91,000 tons, the figures being 5,595,000 tons and 5,686,000 tons, respectively. The number of British ships arriving fell by 57, while the number of Egyptian ships rose by 38. Merchandise landed in 1938 weighed 3,563,579 tons and shipped, 1,300,000 tons. The corresponding figures for 1937 were 3,524,286 tons and 1,516,207 tons.